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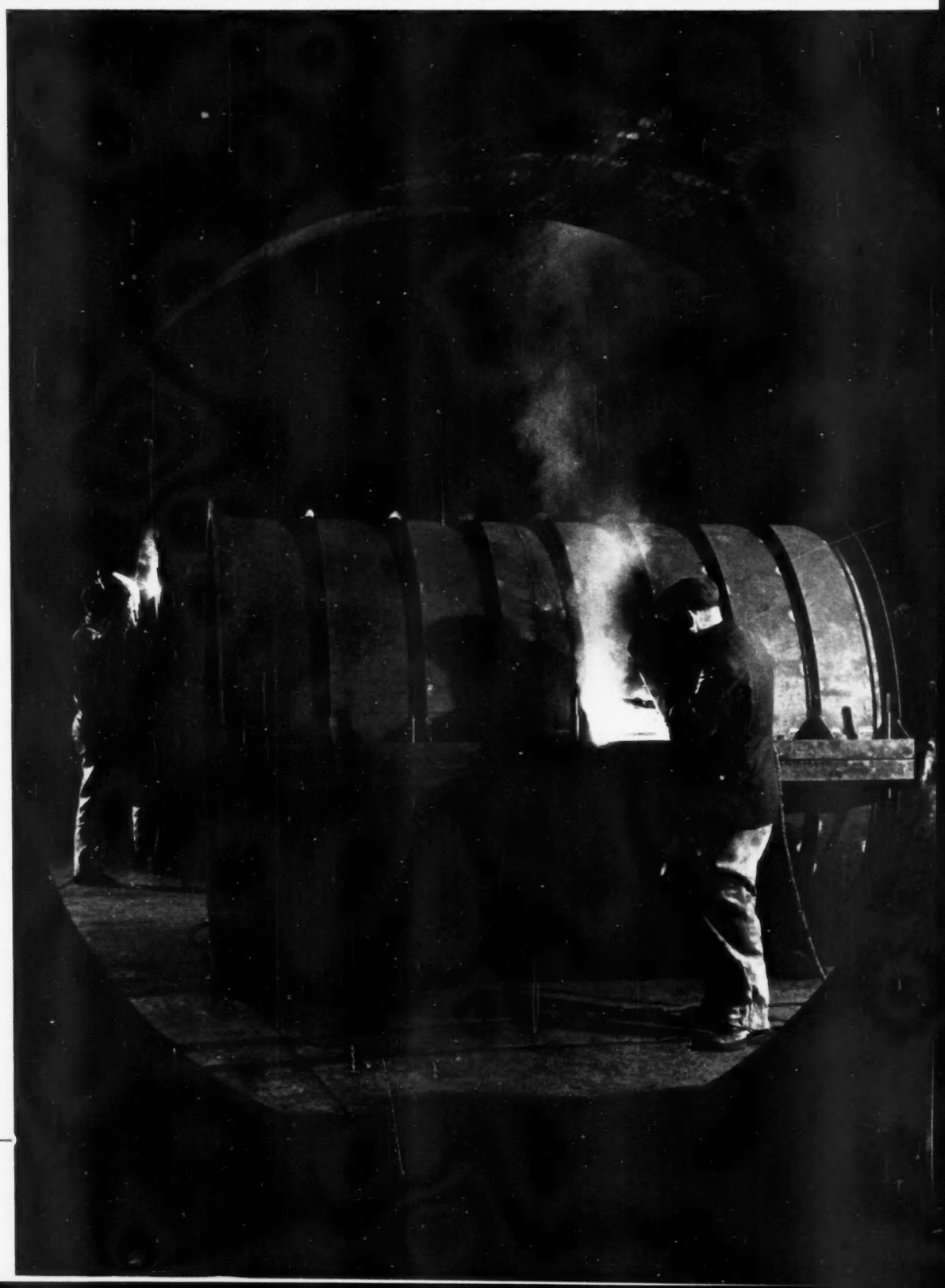

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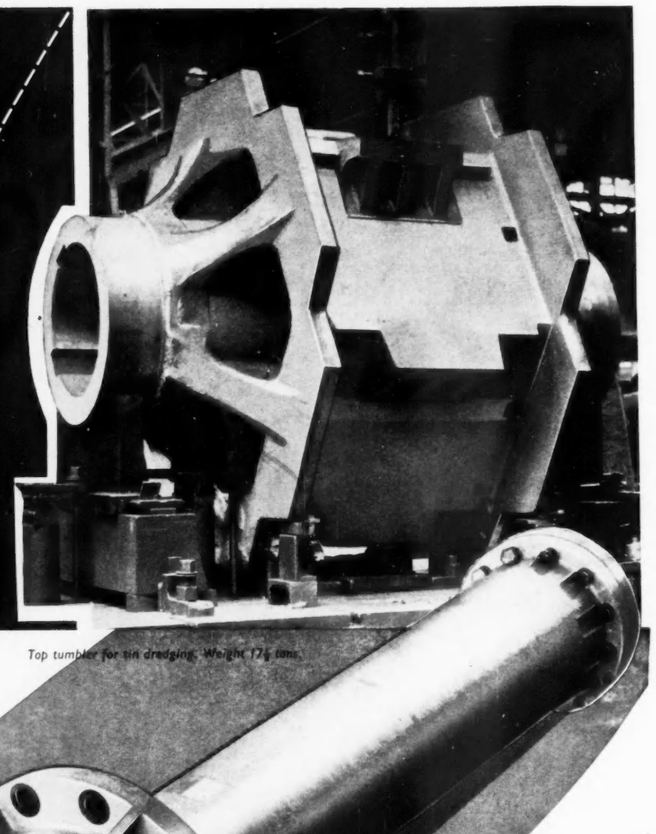

Top tumbler for tin dredging. Weight 17½ tons.

...ality steel castings ...any applications ...ffer certain econ- ... advantages over ... production ...ods. Before final- ... your requirements **...INK OF CASTINGS FIRST** ... consult Hadfields ... name celebrated for ...eels in **CARBON—LOW ...LOY—STAINLESS— ...NGANESE—WEAR ...ESISTING—HEAT ...ESISTING STEELS.**

Tilting cylinder assembly. Weight 18 tons.

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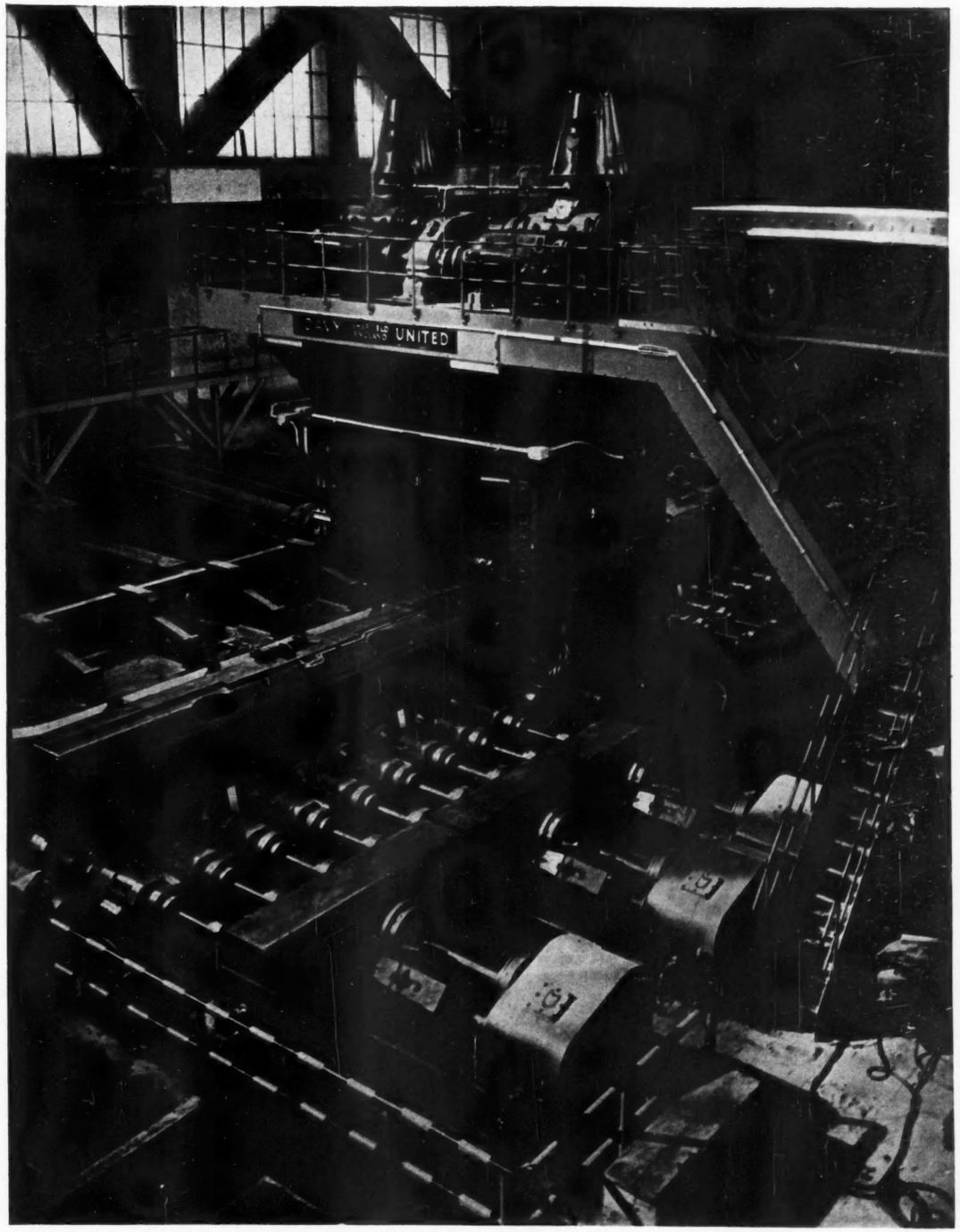

42" Blooming and Slabbing Mill, designed to roll 1,000,000 tons of steel ingots a year, in production in the Aviles Works in Northern Spain of Empresa Nacional Siderurgica

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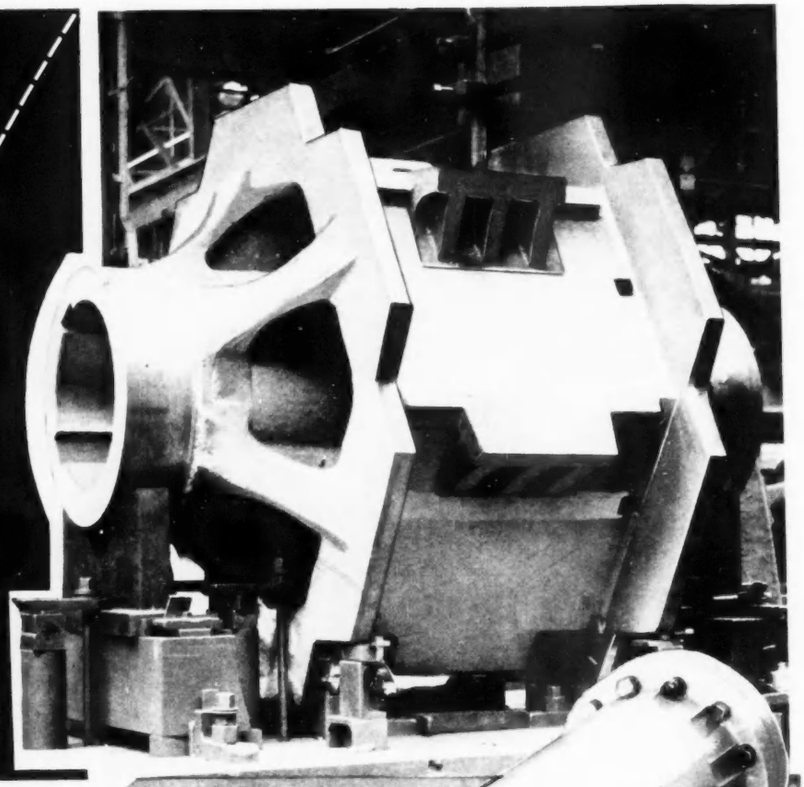

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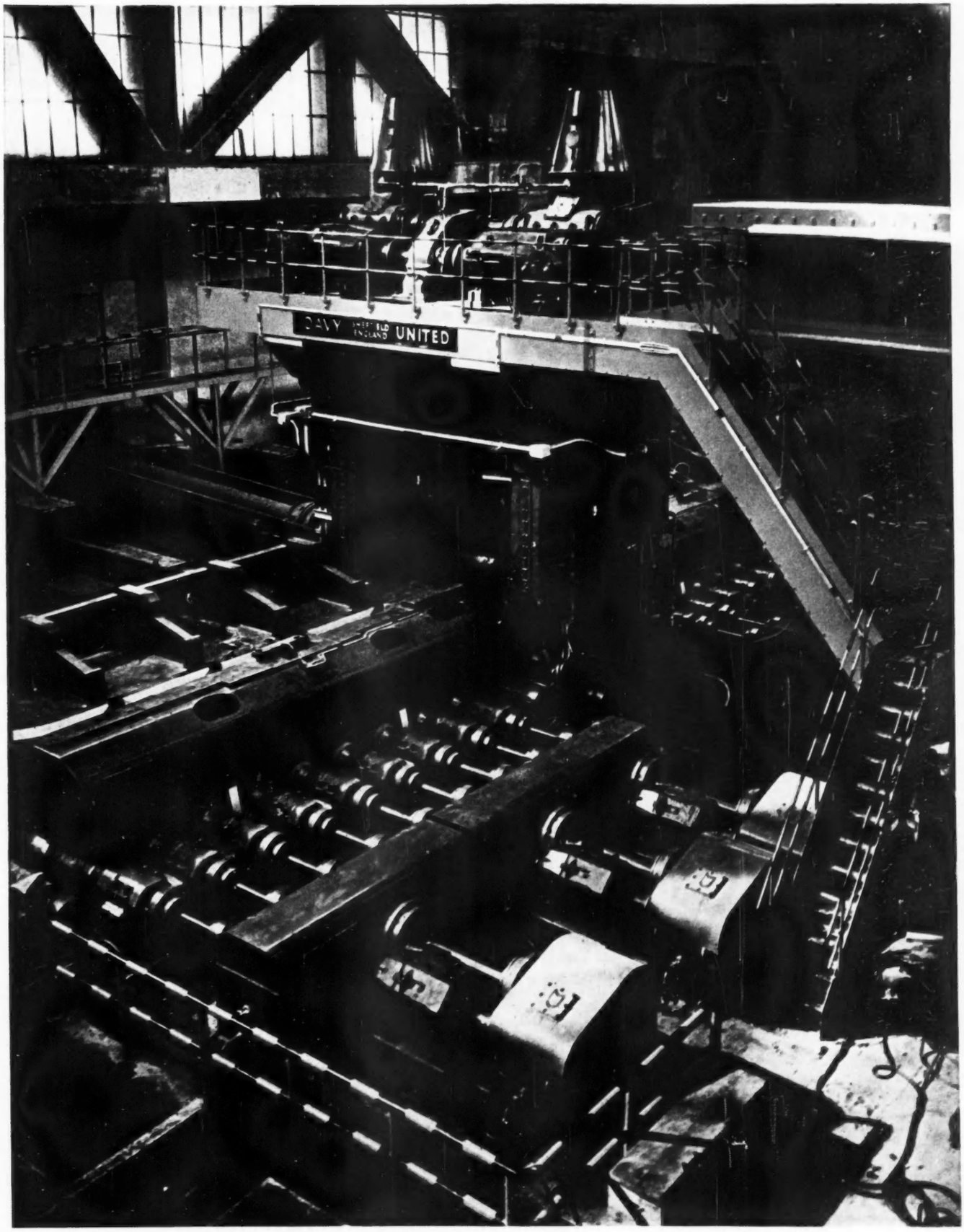

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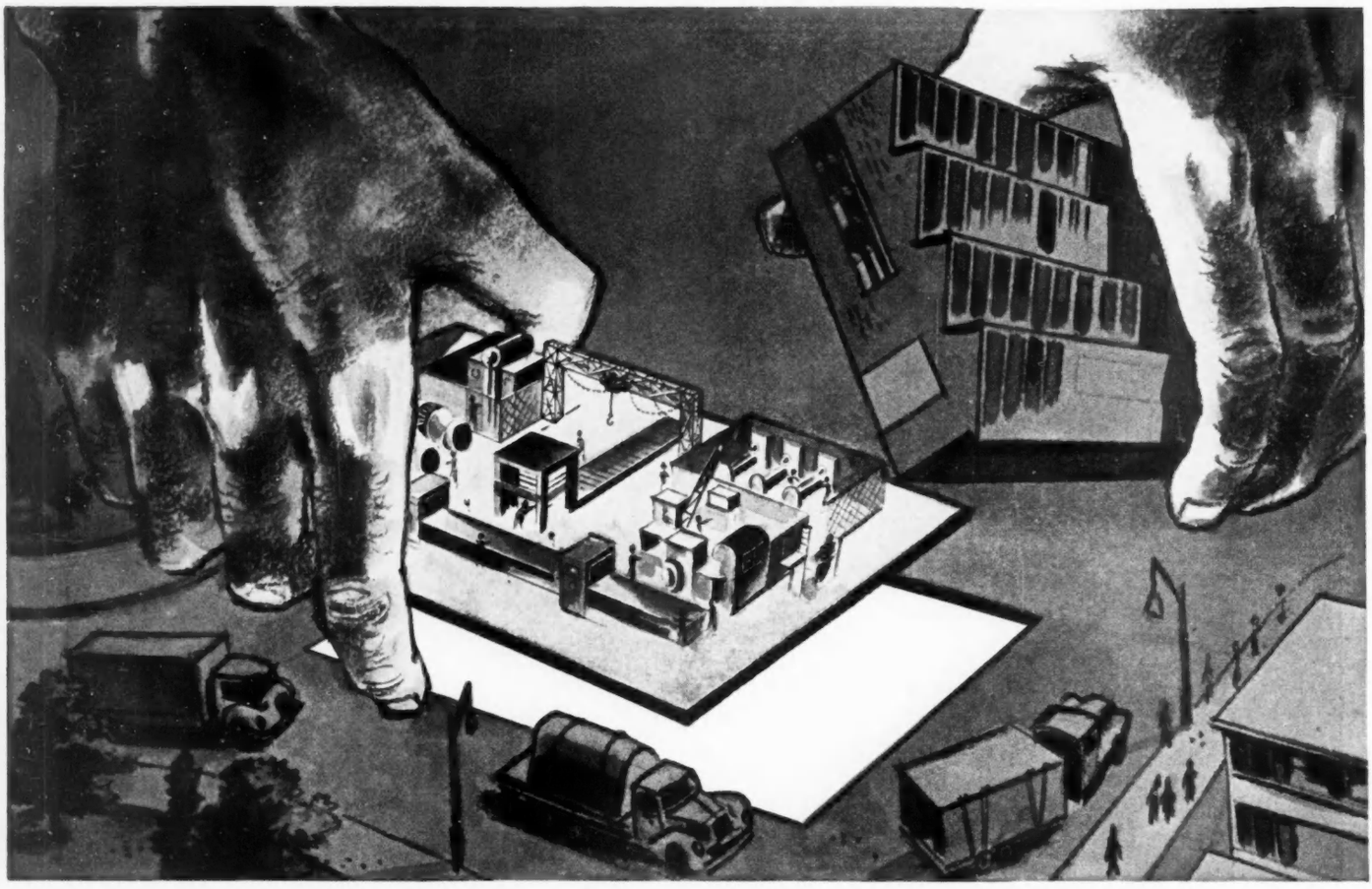

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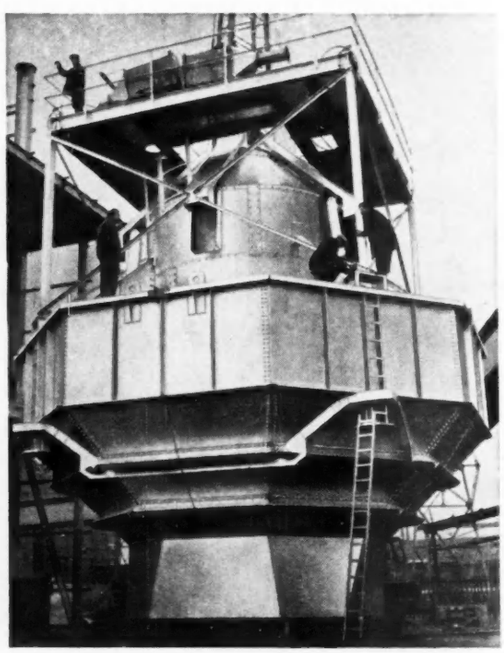

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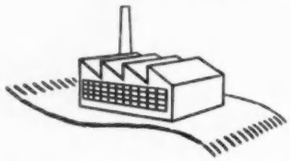

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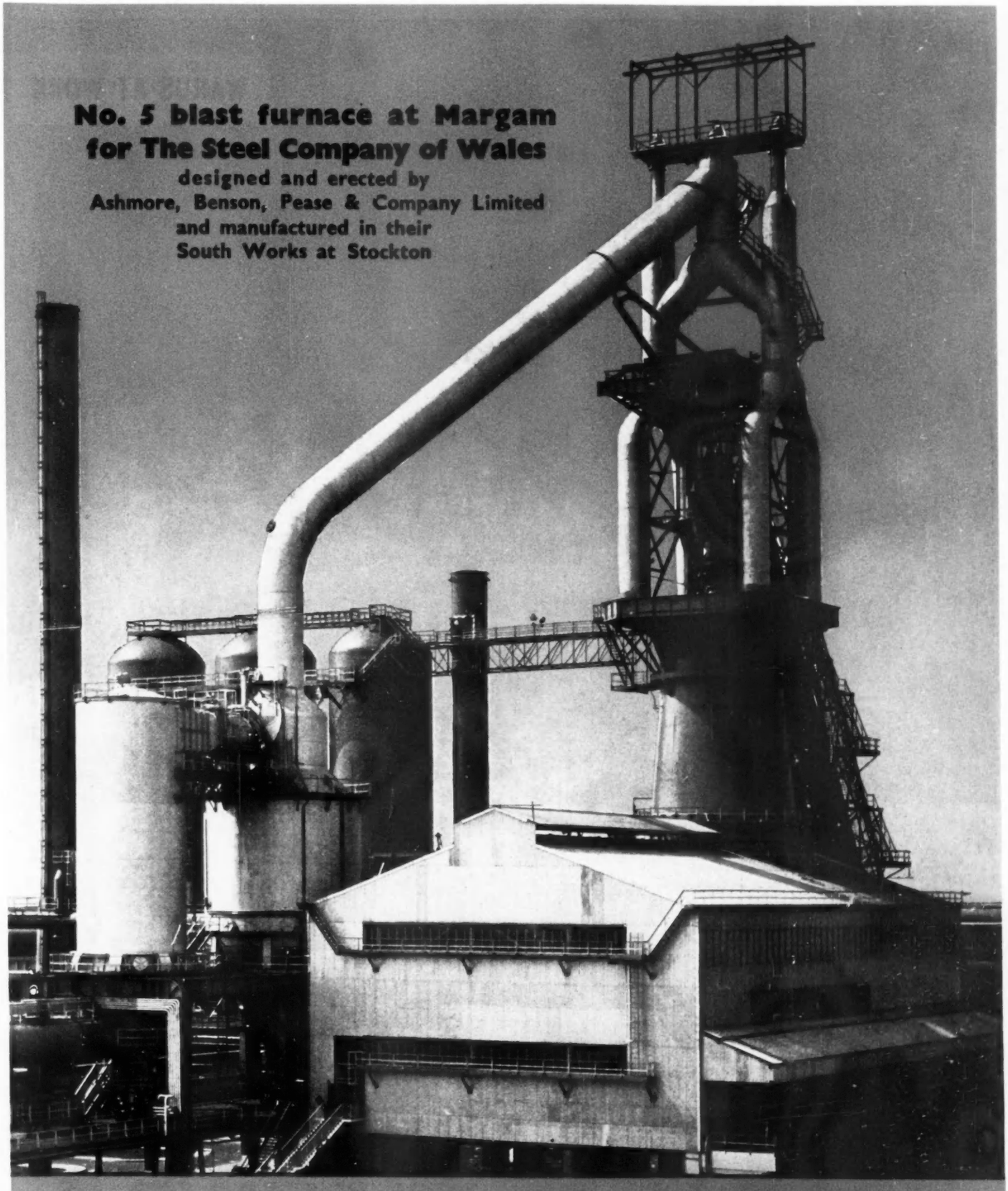
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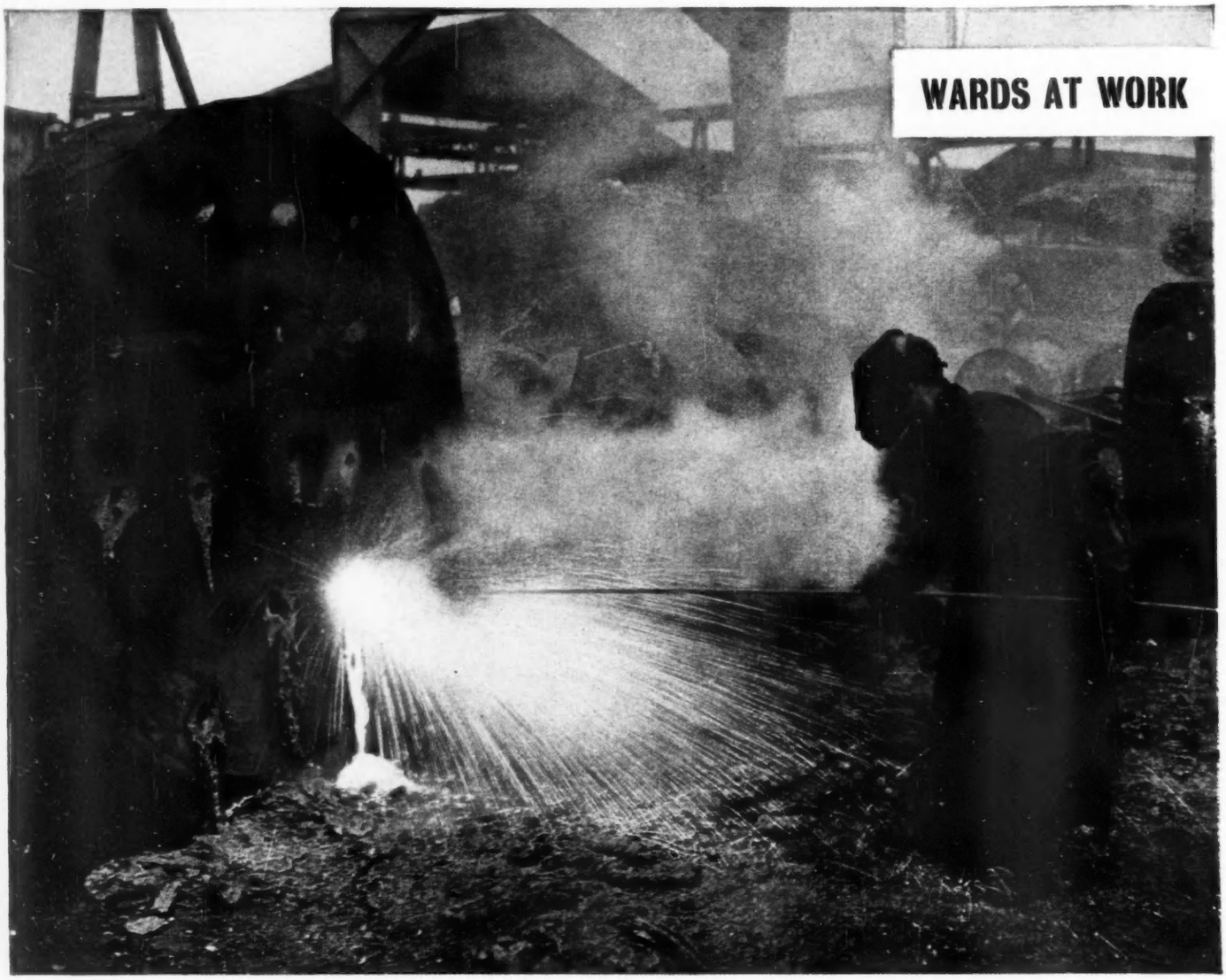

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Fabricating steel shuttering for the columns on the new Gathurst Viaduct, near Wigan. The mild steel electrodes being used are suitable for welding in any position. The viaduct is being constructed for the Lancashire County Council. (*Nurnberg photograph for* ENGINEERING)

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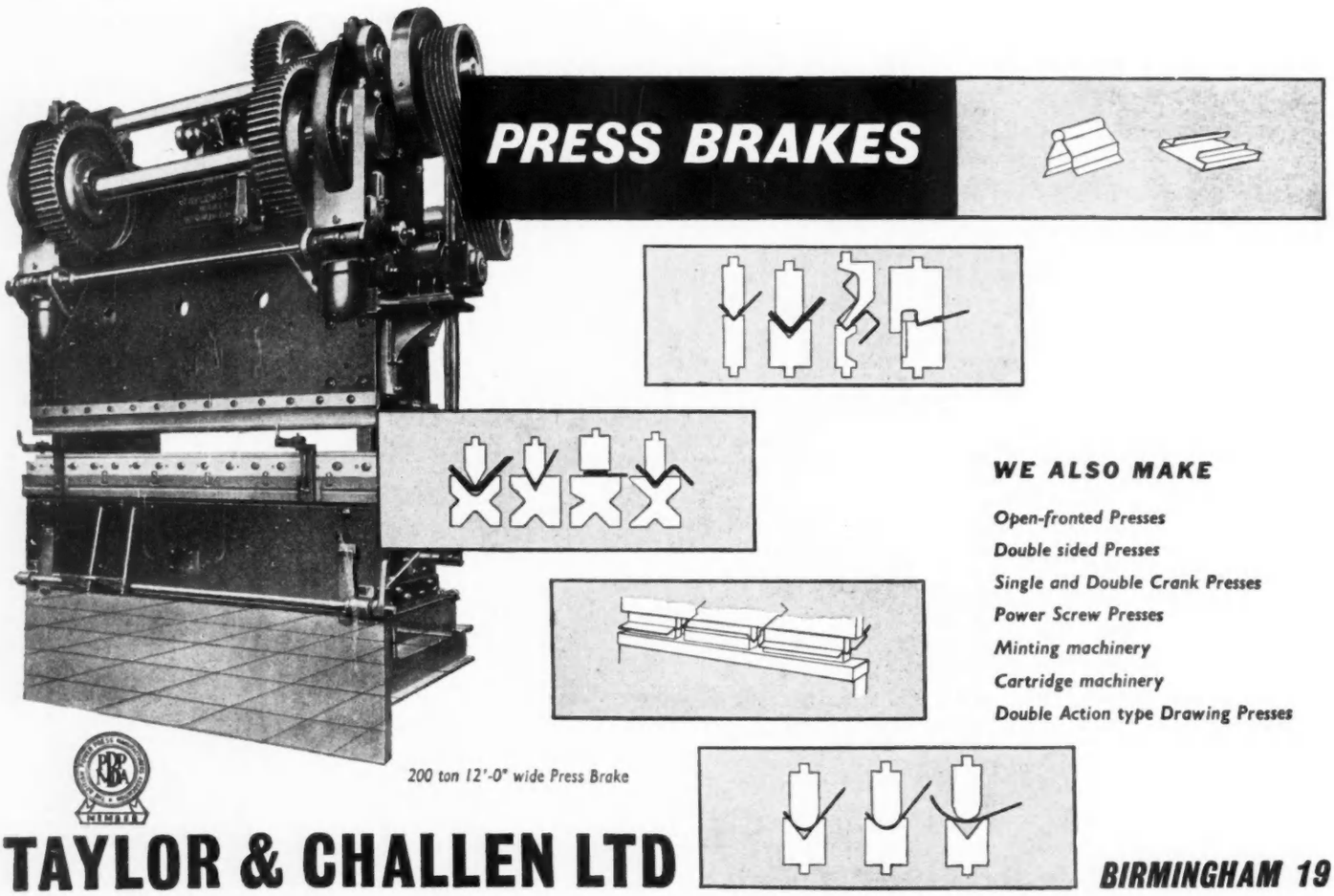

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375 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 380 b.p. horizontal 4-cylinder engine by BLACKSTONE, type 4M13. Direct coupled at 333 r.p.m. to alternator by BRUSH ELECTRICAL, screen protected with direct coupled exciter and switchgear.

TWO 250 kVA 400/440 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SETS,** each incorporating vertical 6-cylinder engine by CROSSLEY BROS., type XVD.6. Direct coupled at 600 r.p.m. to alternator, one by BRITISH THOMSON HOUSTON, the other by METROPOLITAN VICKERS, with direct coupled exciter and switchgear.

180 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating vertical 3-cylinder engine by MIRRLEES BICKERTON & DAY, type J.3. Direct coupled at 750 r.p.m. to alternator by BRUSH ELECTRICAL, with direct coupled exciter and switchgear.

145 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating vertical 3-cylinder engine by BLACKSTONE, type EPV.5. Direct coupled at 500 r.p.m. to alternator by CROMPTON PARKINSON, with direct coupled exciter and switchgear.

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DIESEL ALTERNATOR SETS

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ONE 288 KVA PETTER SS4-GEC, speed 600 r.p.m., 400-440/3/50. Price £3000.
ONE 169 KVA BELLISS 5ALS-LDC, speed 600 r.p.m., 400/3/50. Price £1250.
ONE 125 KVA ECC ALTERNATOR, speed 600 r.p.m., 440/3/50, with control panel. Price £400.
TWO 93 KVA BELLISS 5ALS-LDC, speed 600 r.p.m., 400/3/50. Price £950 each.

All prices are loaded on lorry unless otherwise mentioned. All sets are complete with starting equipment, accessories and control panels. Inspection report available. H. R. SIPPY, 118, PEPYS ROAD, WEST WIMBLEDON, LONDON, S.W.20. TEL.: WIMbledon 5964. C 748

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WILSON 7½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 3 ft. 0 in. between centres, swing in gap 27 in. by 5½ in., dia. of hollow spindle 2¼ in., spindle speeds 26-477 r.p.m., 400-440/3/50 cycles supply.

JONES NO. 1S STANDARD 7½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 36 in. between centres, swing in gap 25 in. by 5½ in., hole in spindle 1¾ in. dia., spindle speeds 26-400 r.p.m., drive from self contained 3 h.p. motor for 400-440/3/50 cycles supply.

STANLEY 7 IN. CENTRES GAP BED S.S. & S.C. LATHE, swing in gap 26 in. by 7½ in., hole in spindle 2¼ in. dia., dist. between centres 36 in., spindle speeds 20-360 r.p.m., drive from 2 h.p. motor for 400-440/3/50 cycles supply.

ROLLO 7 IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 36 in. between centres, swing in front of spindle nose with gap piece removed 25 in. by 10 in., 2 in. dia. hollow spindle, 14 spindle speeds 18-350 r.p.m., 440/3/50 cycles motor drive.

HARRISON 4½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 24 in. between centres, ¾ in. dia. hollow spindle, 8 spindle speeds 18-480 r.p.m., fitted with 3-feed gearbox, arranged for self contained motor drive with 2 h.p., with 9 in. faceplate.

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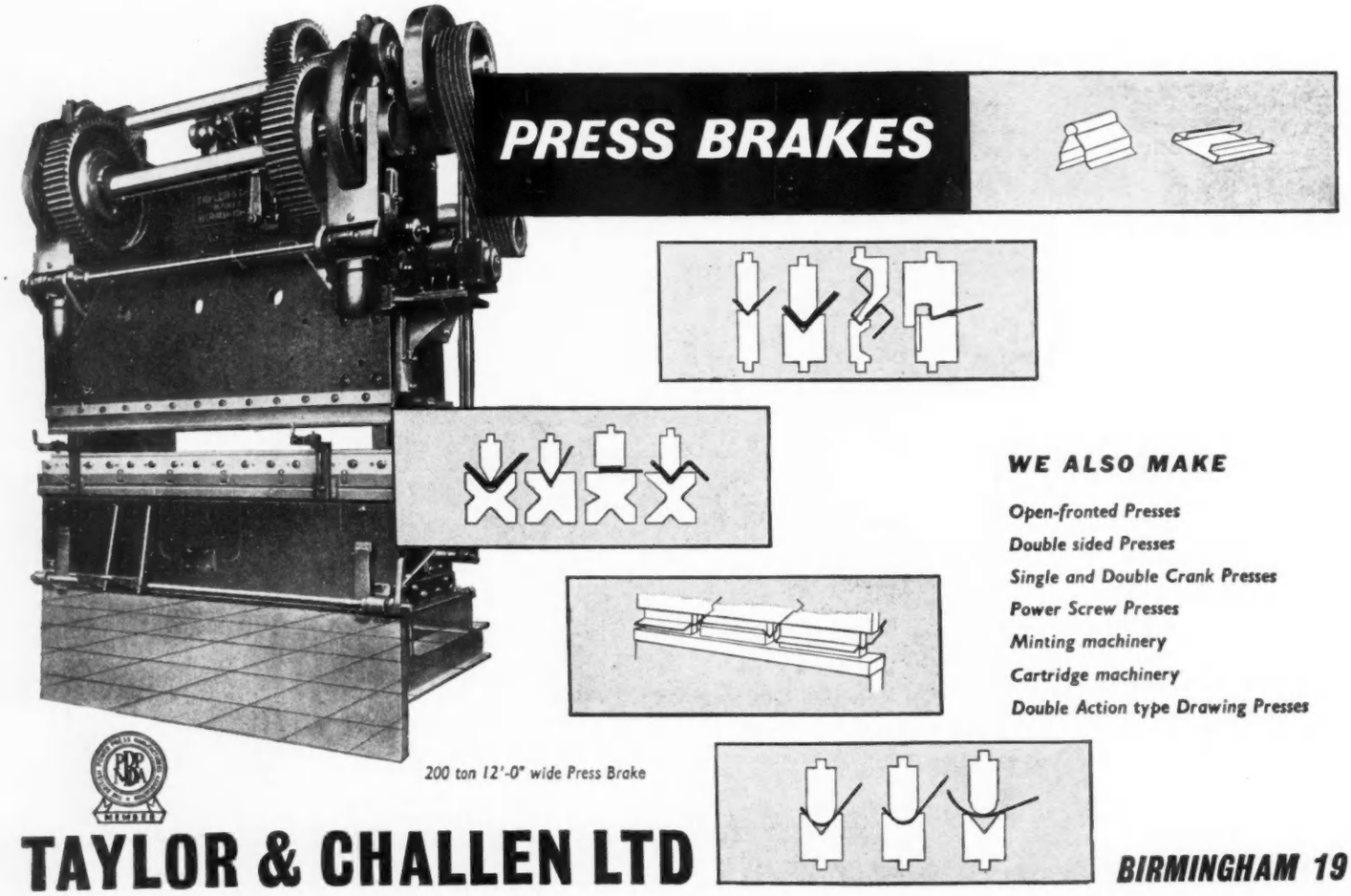

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375 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating 380 h.p. horizontal 4-cylinder engine by BLACKSTONE, type 4M13. Direct coupled at 333 r.p.m. to alternator by BRUSH ELECTRICAL, screen protected with direct coupled exciter and switchgear.

TWO 250 kVA 400/440 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SETS,** each incorporating vertical 6-cylinder engine by CROSSLEY BROS., type XVD.6. Direct coupled at 600 r.p.m. to alternator, one by BRITISH THOMSON HOUSTON, the other by METROPOLITAN VICKERS, with direct coupled exciter and switchgear.

180 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating vertical 3-cylinder engine by MIRRLEES BICKERTON & DAY, type J.3. Direct coupled at 750 r.p.m. to alternator by BRUSH ELECTRICAL, with direct coupled exciter and switchgear.

145 kVA 400 volts 3 phase 50 cycles **DIESEL ENGINE DRIVEN ALTERNATOR SET** incorporating vertical 5-cylinder engine by BLACKSTONE, type EPV.5. Direct coupled at 500 r.p.m. to alternator by CROMPTON PARKINSON, with direct coupled exciter and switchgear.

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STEEL, ALUMINIUM, BRASS, SHEET AND OFFCUT, 10 to 24G. Small or large quantities. Cash payment.—DYAS & FOWLE, 41, LOUDOUN ROAD, N.W.8. MAI. 2711, 5477. G 663

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ONE E.N. MASON STAINLESS STEEL AUTOMATIC WASHING SINK.
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APPROX. 100 SHEET FILM HANGERS.
A NUMBER OF SPARE PARTS.

To install this unit new would cost about £2500. What Offers? We would consider selling each item separately. Buyer to collect.

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DIESEL ALTERNATOR SETS

TWO 560 KVA NATIONAL BAR7-ECC, speed 300 r.p.m., 440/3/50. Complete with all equipment, bottles, AVR, etc. Price £4000 on site for the two.
ONE 470 KVA MIRRLEES HF5-BRUCE PEEBLES, speed 375 r.p.m., 440/3/50. Price £3000.
ONE 288 KVA PETTER 8S4-GEC, speed 600 r.p.m., 400-440/3/50. Price £3000.
ONE 169 KVA BELLISS 5ALS-LDC, speed 600 r.p.m., 400/3/50. Price £1250.
ONE 125 KVA ECC ALTERNATOR, speed 600 r.p.m., 440/3/50, with control panel. Price £400.
TWO 93 KVA BELLISS 5ALS-LDC, speed 600 r.p.m., 400/3/50. Price £950 each.

All prices are loaded on lorry unless otherwise mentioned. All sets are complete with starting equipment, accessories and control panels. Inspection report available. B. R. SIPPY, 118, PEPYS ROAD, WEST WIMBLEDON, LONDON, S.W.20. TEL.: WIMbledon 5964. C 748

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WILSON 7½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 3 ft. 0 in. between centres, swing in gap 27 in. by 5¼ in., dia. of hollow spindle 2¼ in., spindle speeds 26-477 r.p.m., 400-440/3/50 cycles supply.
JONES NO. 15 STANDARD 7½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 36 in. between centres, swing in gap 25 in. by 5½ in., hole in spindle 1⅞ in. dia., spindle speeds 26-400 r.p.m., drive from self contained 3 h.p. motor for 400-440/3/50 cycles supply.
STANLEY 7 IN. CENTRES GAP BED S.S. & S.C. LATHE, swing in gap 26 in. by 7½ in., hole in spindle 2¼ in. dia., dist. between centres 36 in., spindle speeds 20-360 r.p.m., drive from 2 h.p. motor for 400-440/3/50 cycles supply.
ROLLO 7 IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 36 in. between centres, swing in front of spindle nose with gap piece removed 25 in. by 10 in., 2 in. dia. hollow spindle, 14 spindle speeds 18-350 r.p.m., 440/3/50 cycles motor drive.
HARRISON 4½ IN. CENTRES GAP BED S.S. & S.C. LATHE, to admit 24 in. between centres, ¾ in. dia. hollow spindle, 8 spindle speeds 18-480 r.p.m., fitted with 3-feed gearbox, arranged for self contained motor drive with 2 h.p., with 9 in. faceplate.
MITCHELL OF KEIGHLEY 8½ IN. CENTRES S.S. & S.C. LATHE on 8 ft. 0 in. gap bed, swing in gap 32 in. dia. by 11 in. in front of spindle nose, admits 4 ft. 4 in. between centres, 3 in. dia. hollow spindle, 8 spindle speeds from 30-400 r.p.m. Arranged for vee rope drive for 400-440/3/50 cycles.
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For 'Engineering' Appointments Section, turn to the centre of editorial section.

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CONTINUED

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THE PROPRIETOR OF BRITISH PATENT NO. 652686 for "PINKING SHEARS AND METHOD OF MANUFACTURING SAME," desires to enter into negotiations with a firm or firms for the sale of the patent or for the grant of licences thereunder.—Further particulars may be obtained from MARKS & CLERK, 57 and 58, LINCOLN'S INN FIELDS, LONDON, W.C.2. C 745

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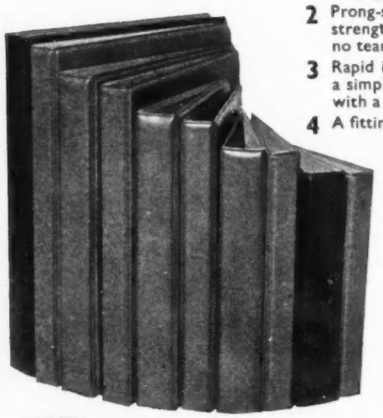

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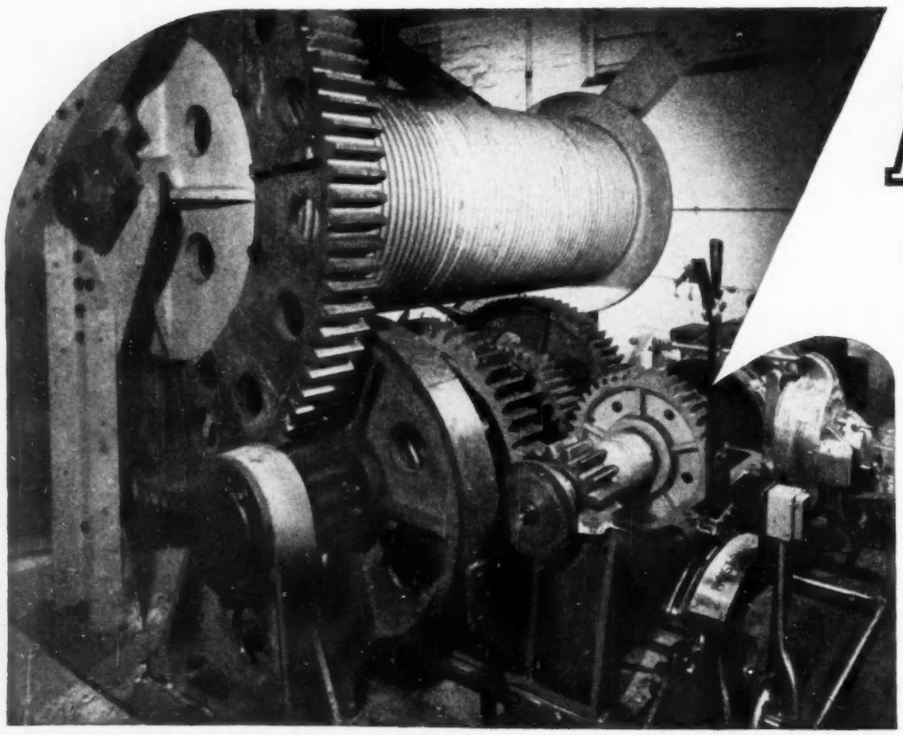

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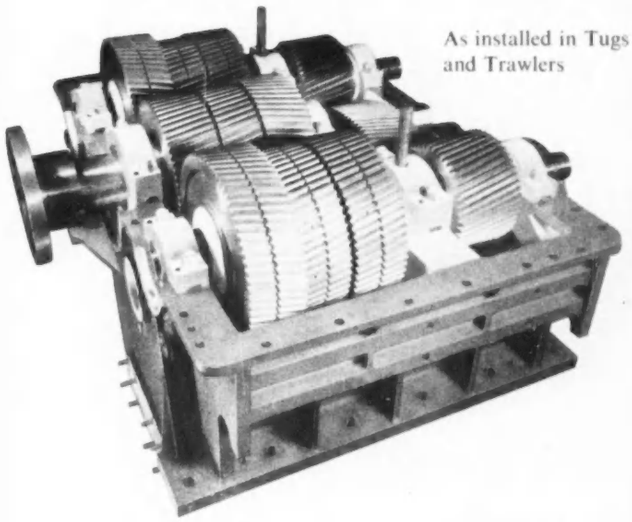

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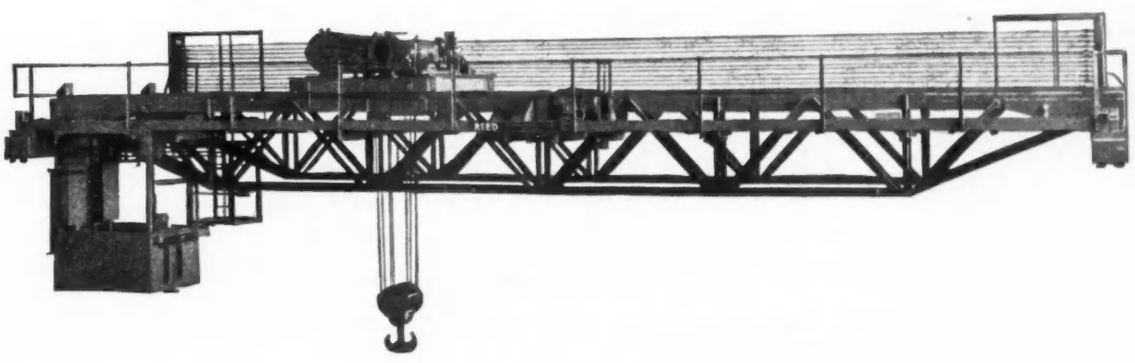

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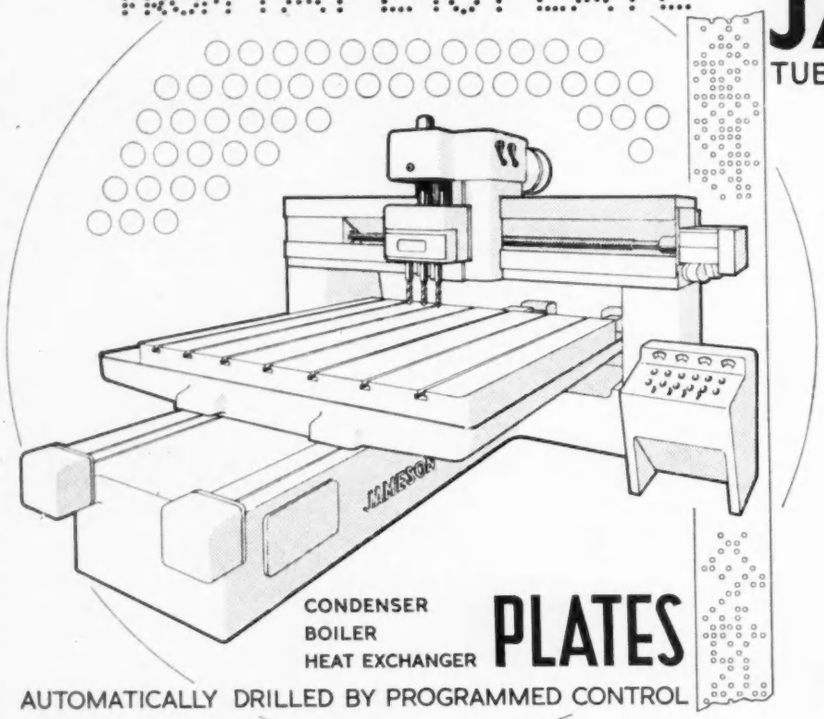

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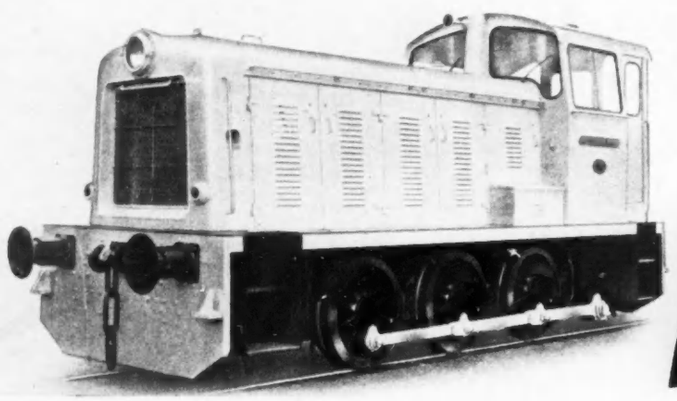

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Starting Tractive Effort 17,860 lbs.

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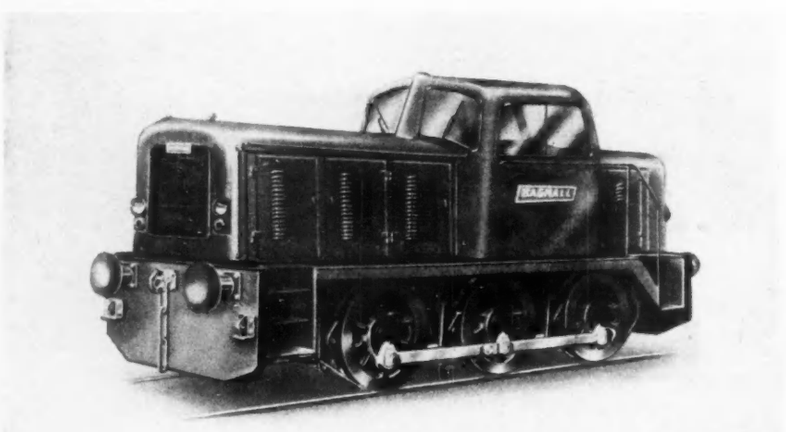

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Wheel arrangement 0-6-0
Dorman 6QAT diesel engine 342 H.P. at 1800 r.p.m
Weight 48 tons
Starting Tractive Effort 32,300 lbs.

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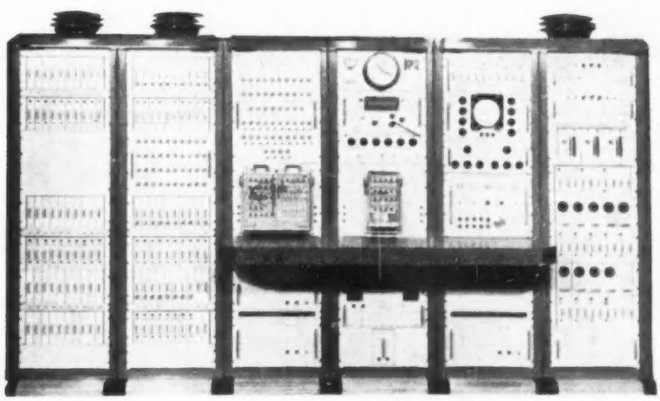

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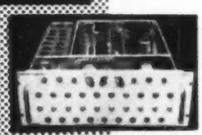

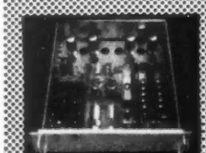

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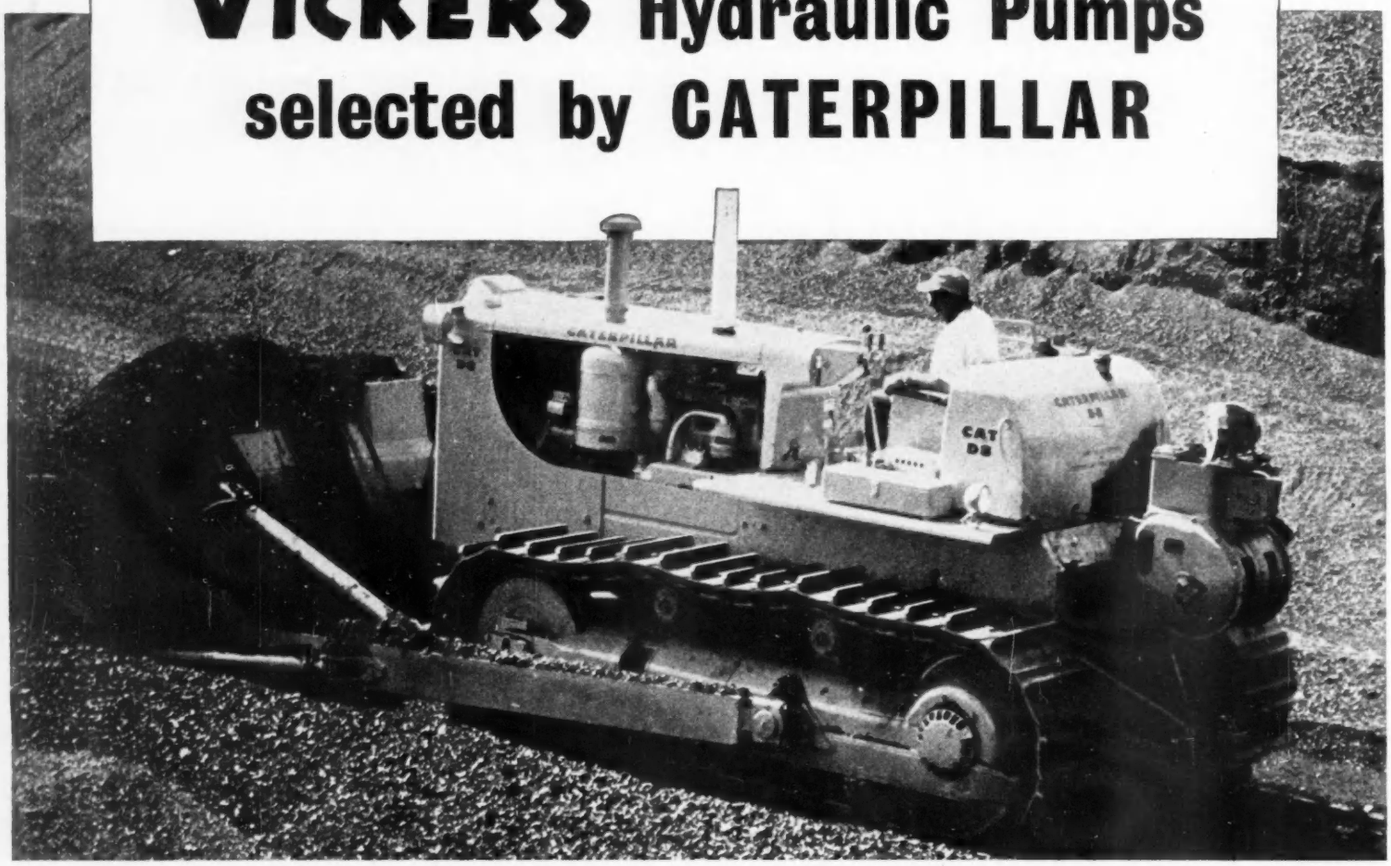

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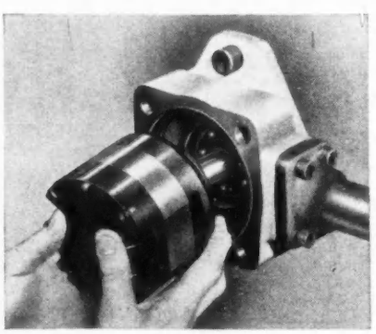

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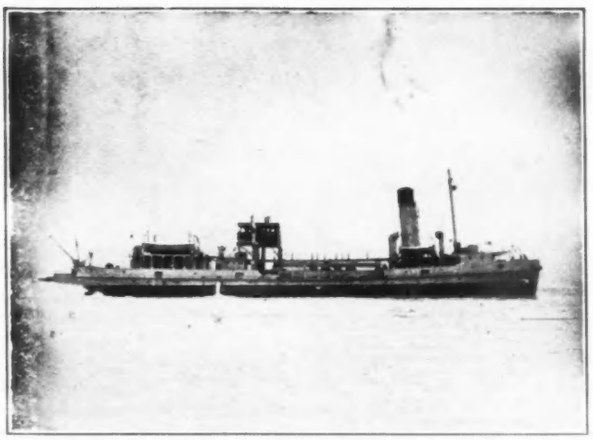

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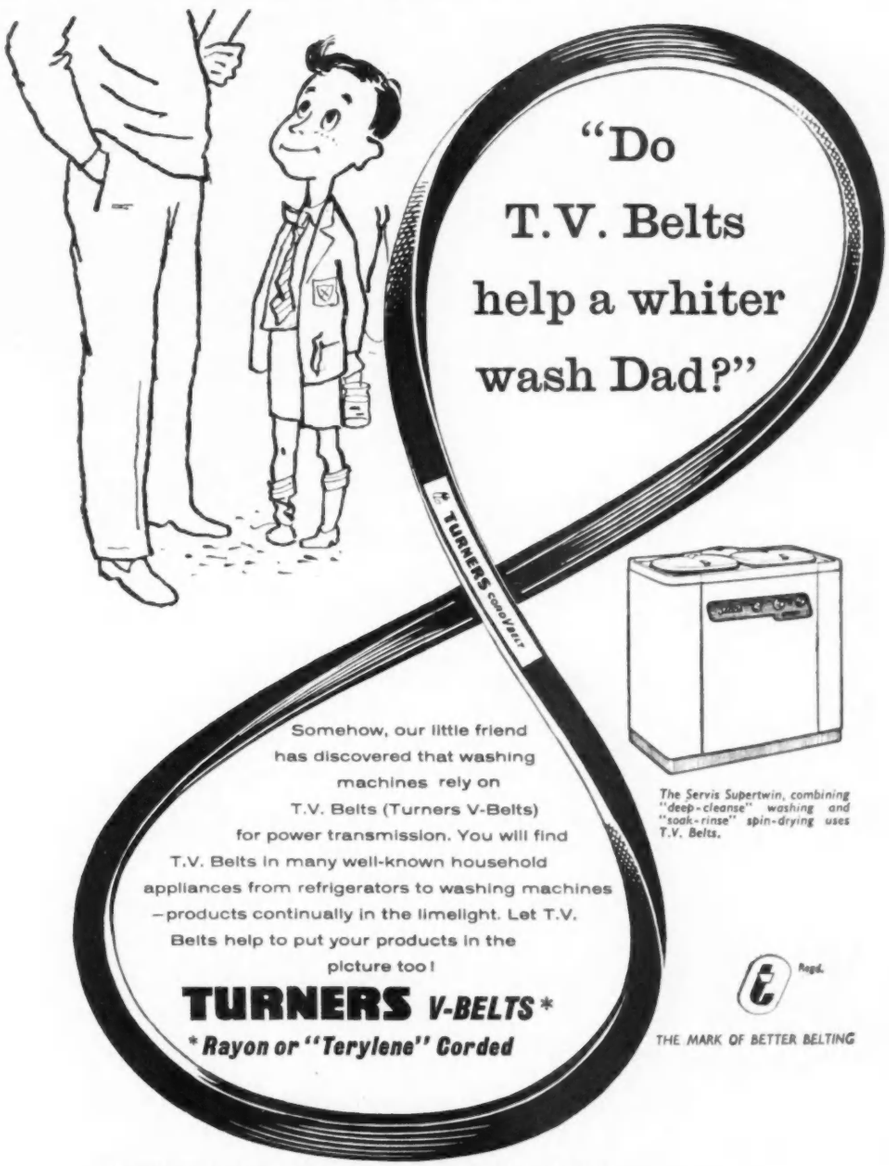
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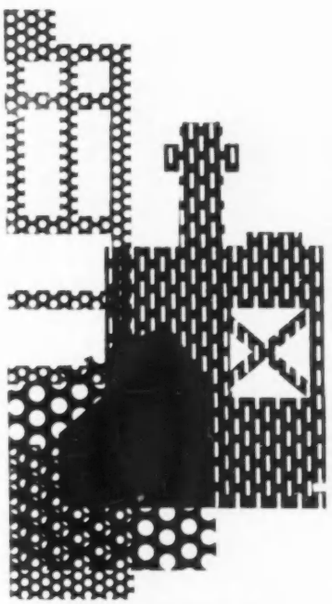

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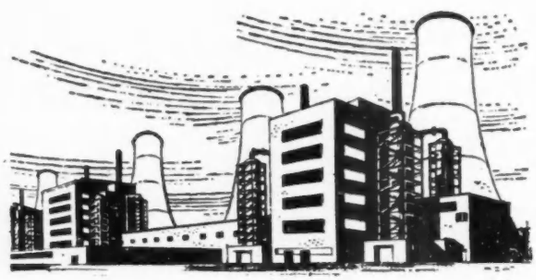

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Heat Flow Research—Analysis of Brake Drum Temperature in Racing Cars, by T. P. Newcomb, M.Sc., A.Inst.P., Research Division, Ferodo Limited.

Promising Future of Vertical Take-Off, by H. G. Conway, M.A., M.I.Mech.E., F.R.Ae.S., Director and Chief Engineer, Short Brothers & Harland Limited. (Read at the British Association Meeting in September, 1959, under the title " VTOL—An Aeronautical Challenge ").

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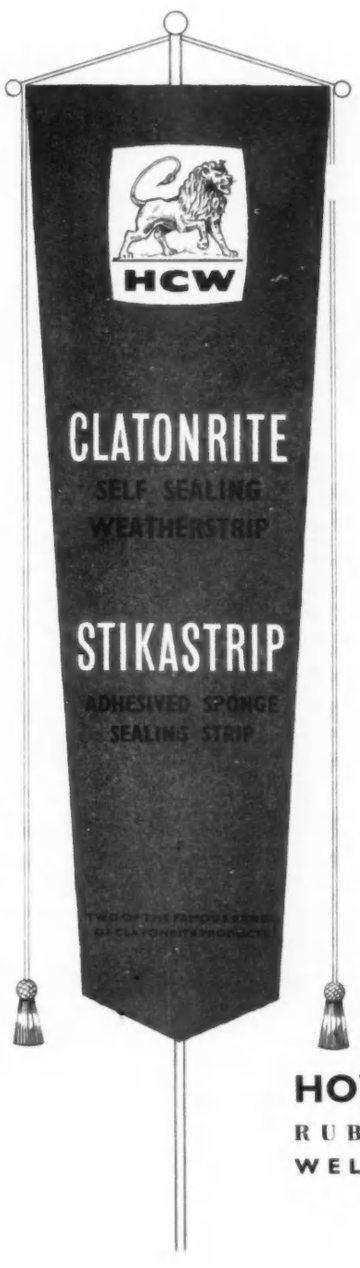

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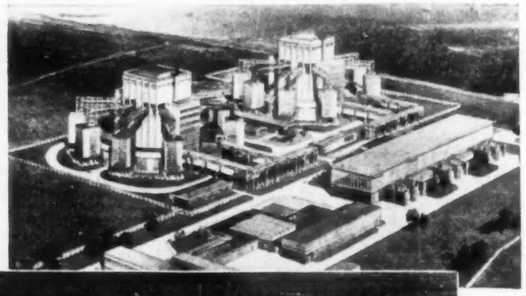

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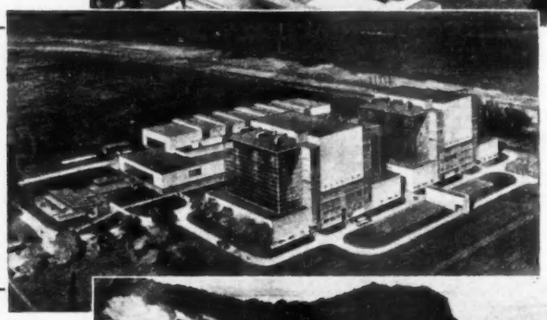
BRADWELL
(The Nuclear Power Plant Company Ltd.)



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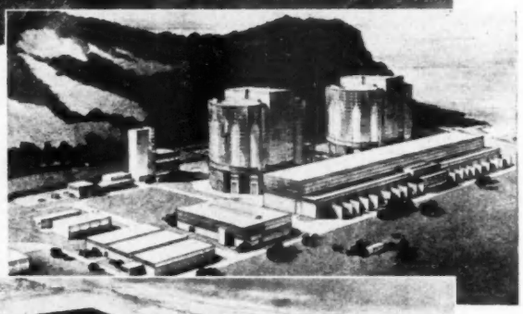
HUNTERSTON (G.E.C. — Simon-Carves Group)



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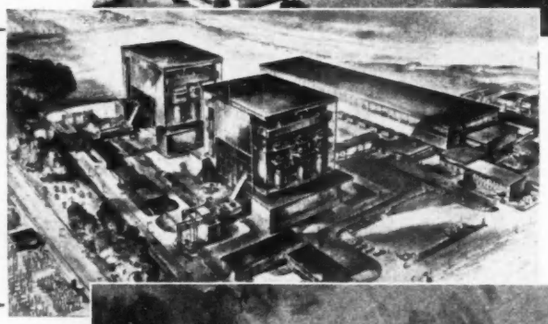
HINKLEY POINT
(English Electric, Babcock & Wilcox, Taylor Woodrow Atomic Power Group)



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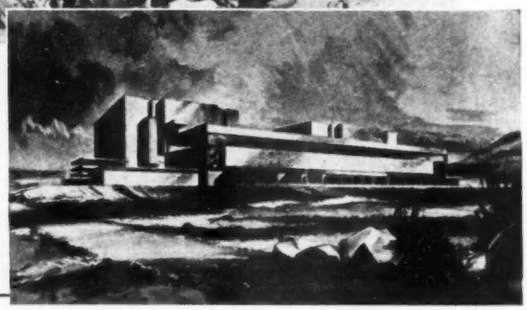
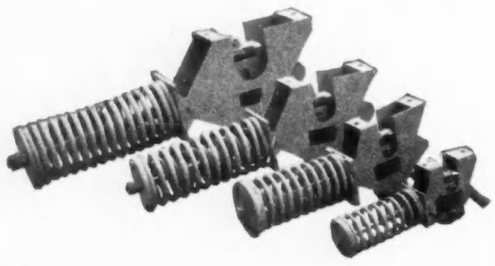
TRAWSFYNYDD (Atomic Power Constructions Ltd.)
(An impression by Sir Basil Spence, Consultant Architect to Nuclear Civil Constructors, showing how the design blends into the landscape of Snowdonia)





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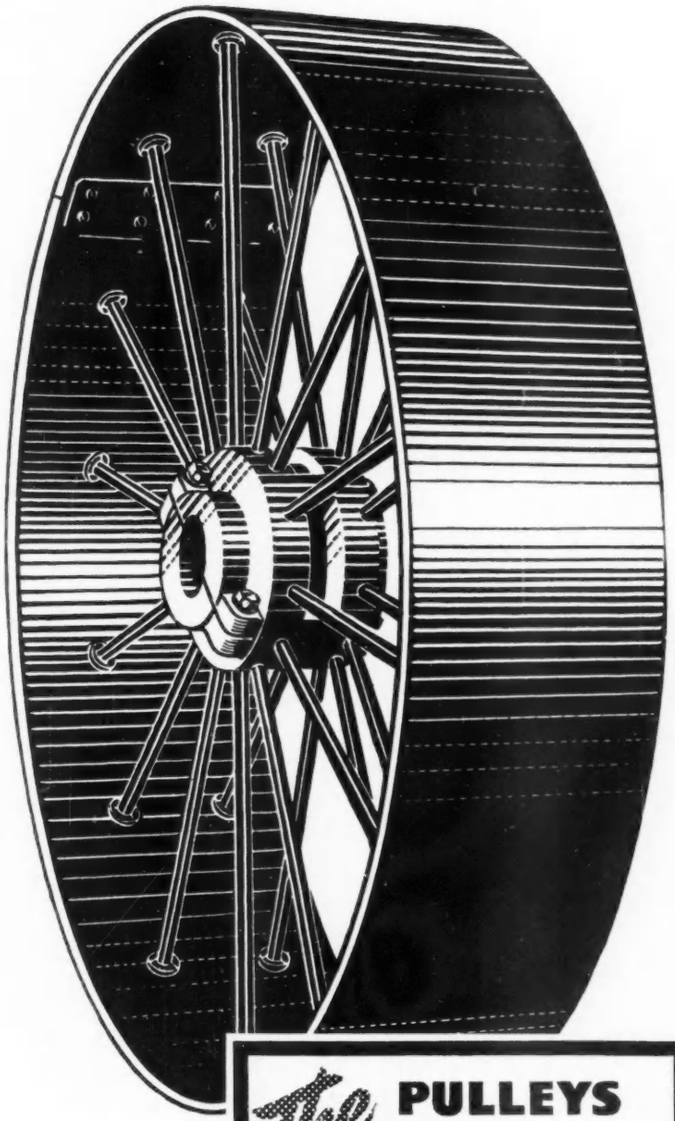

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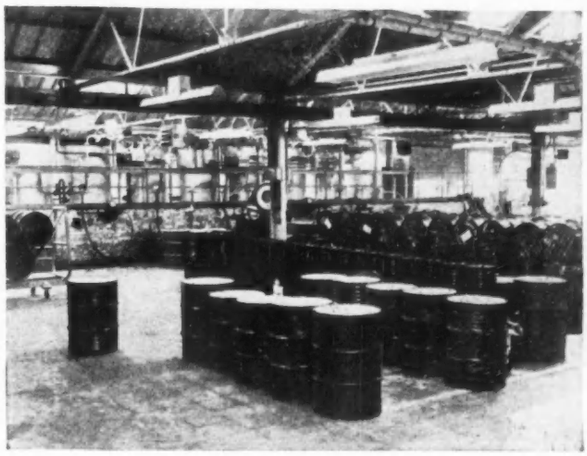

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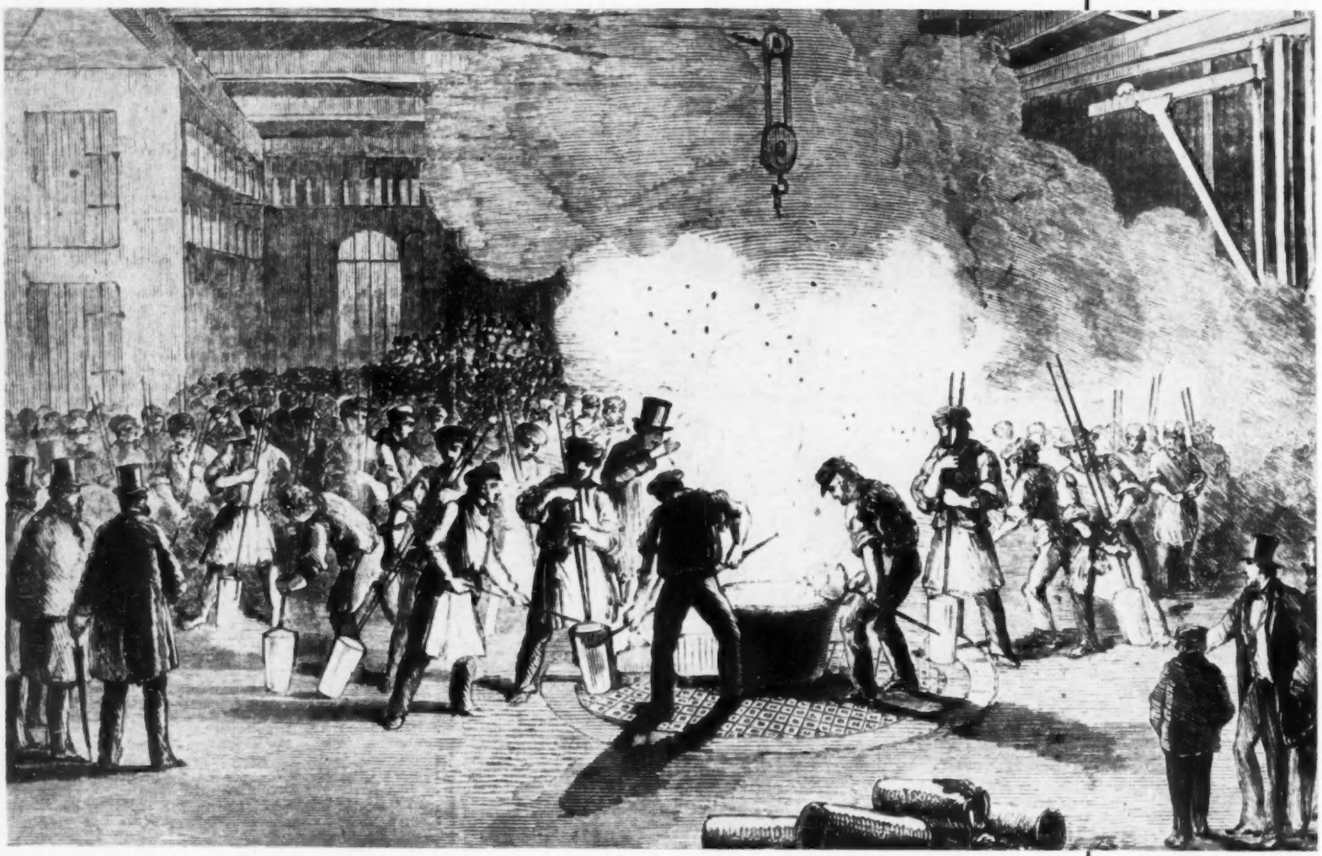
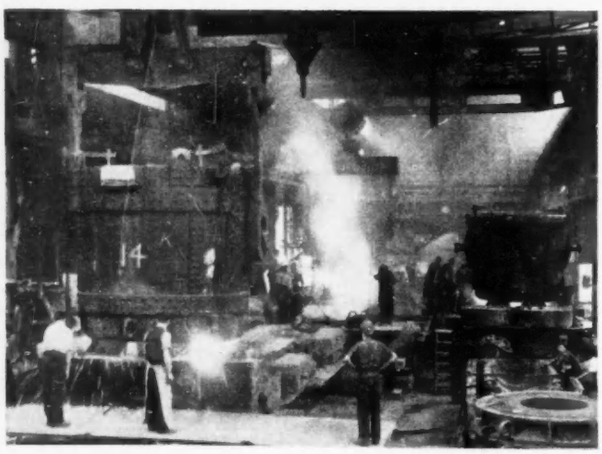


and still leading in 1960



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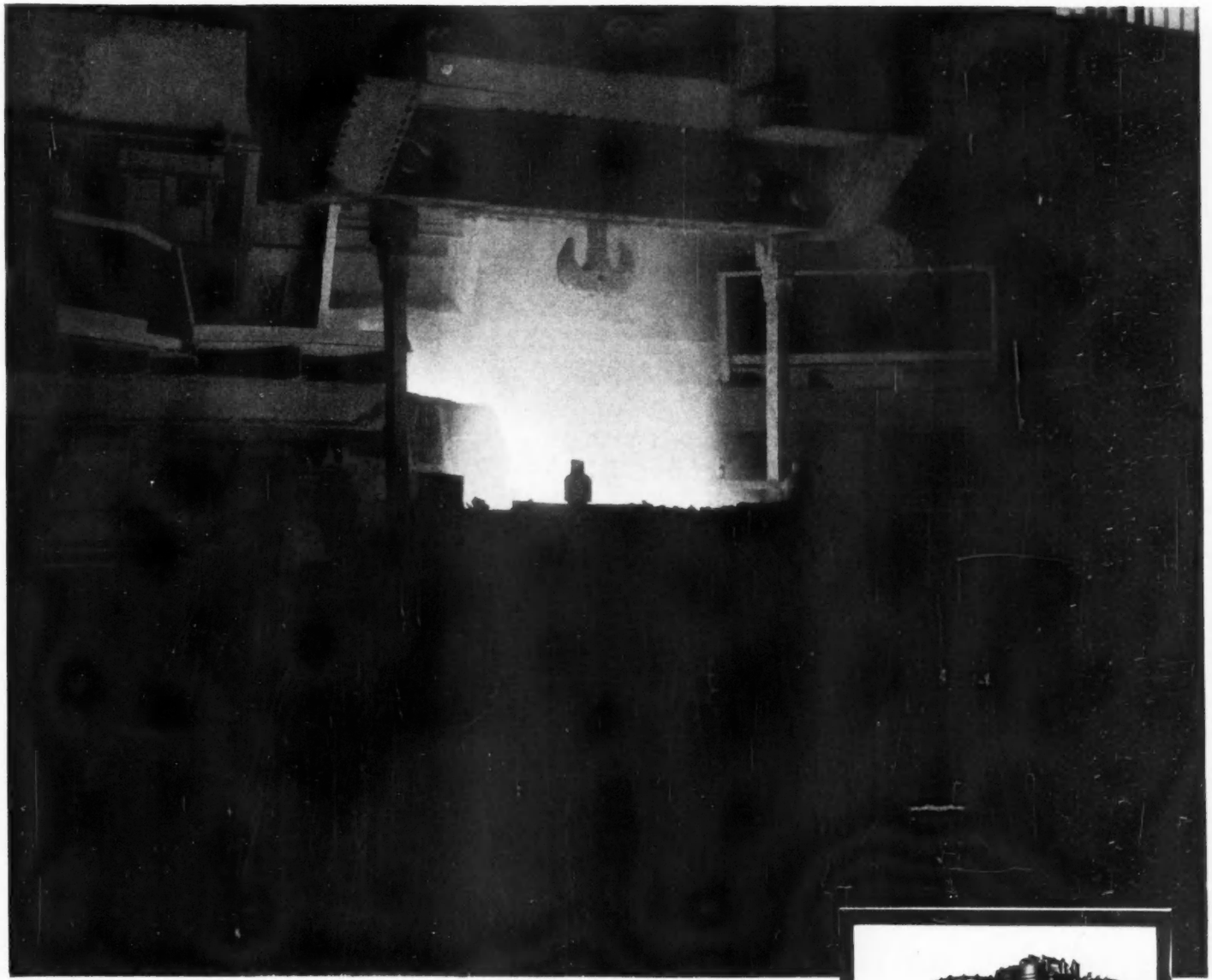
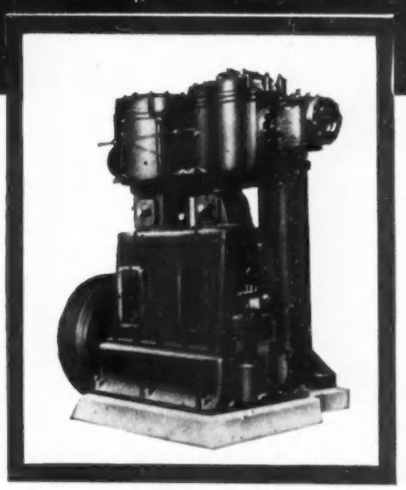


Photograph by courtesy of United Steel Companies Ltd.



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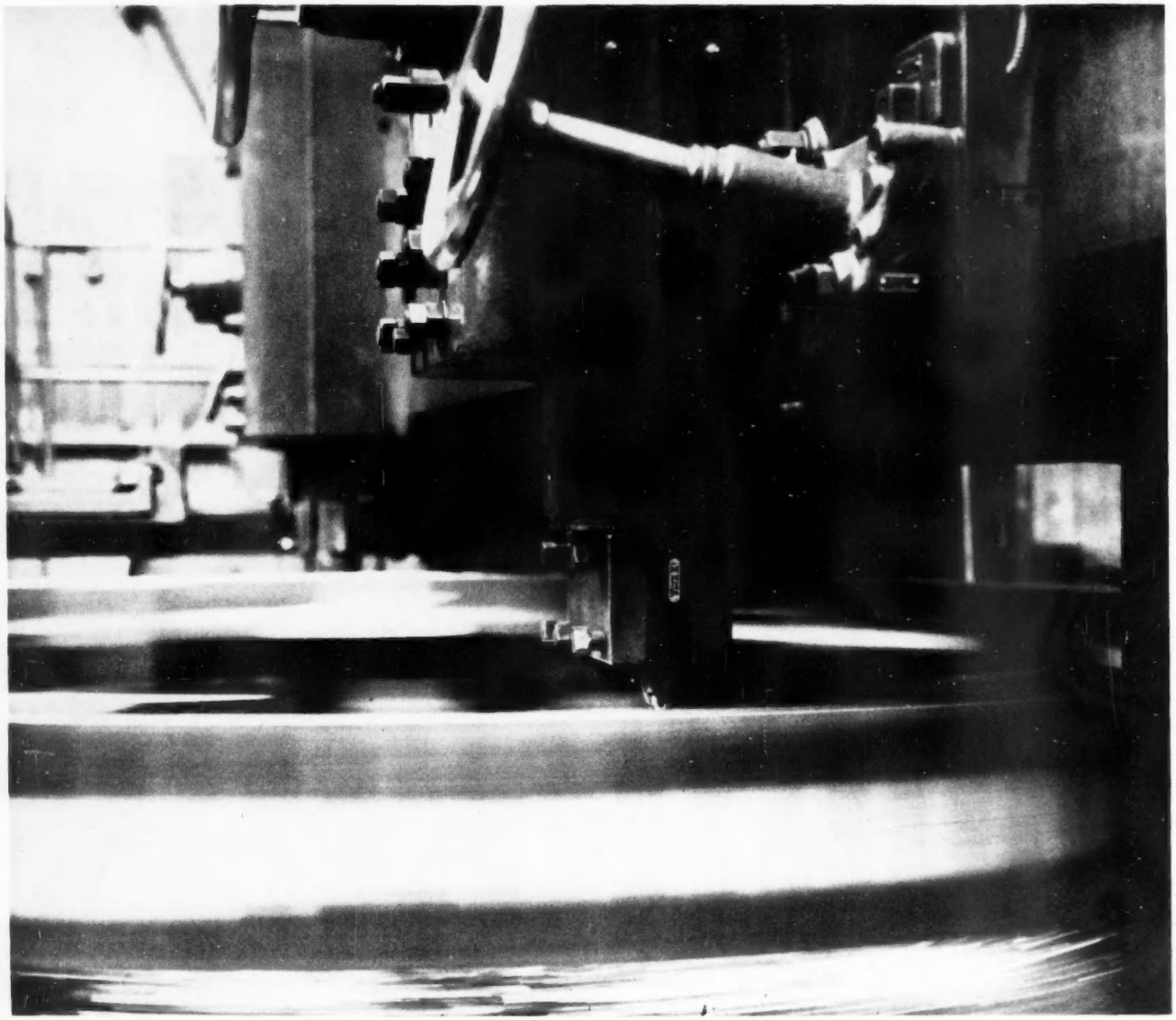

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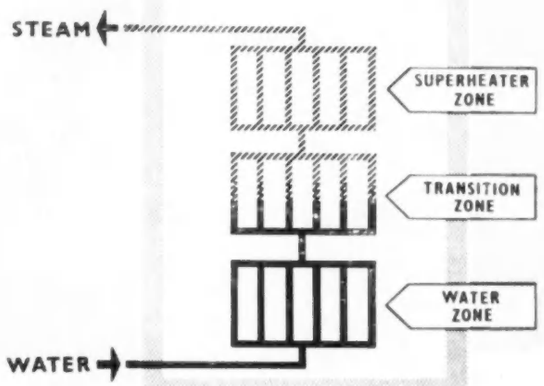

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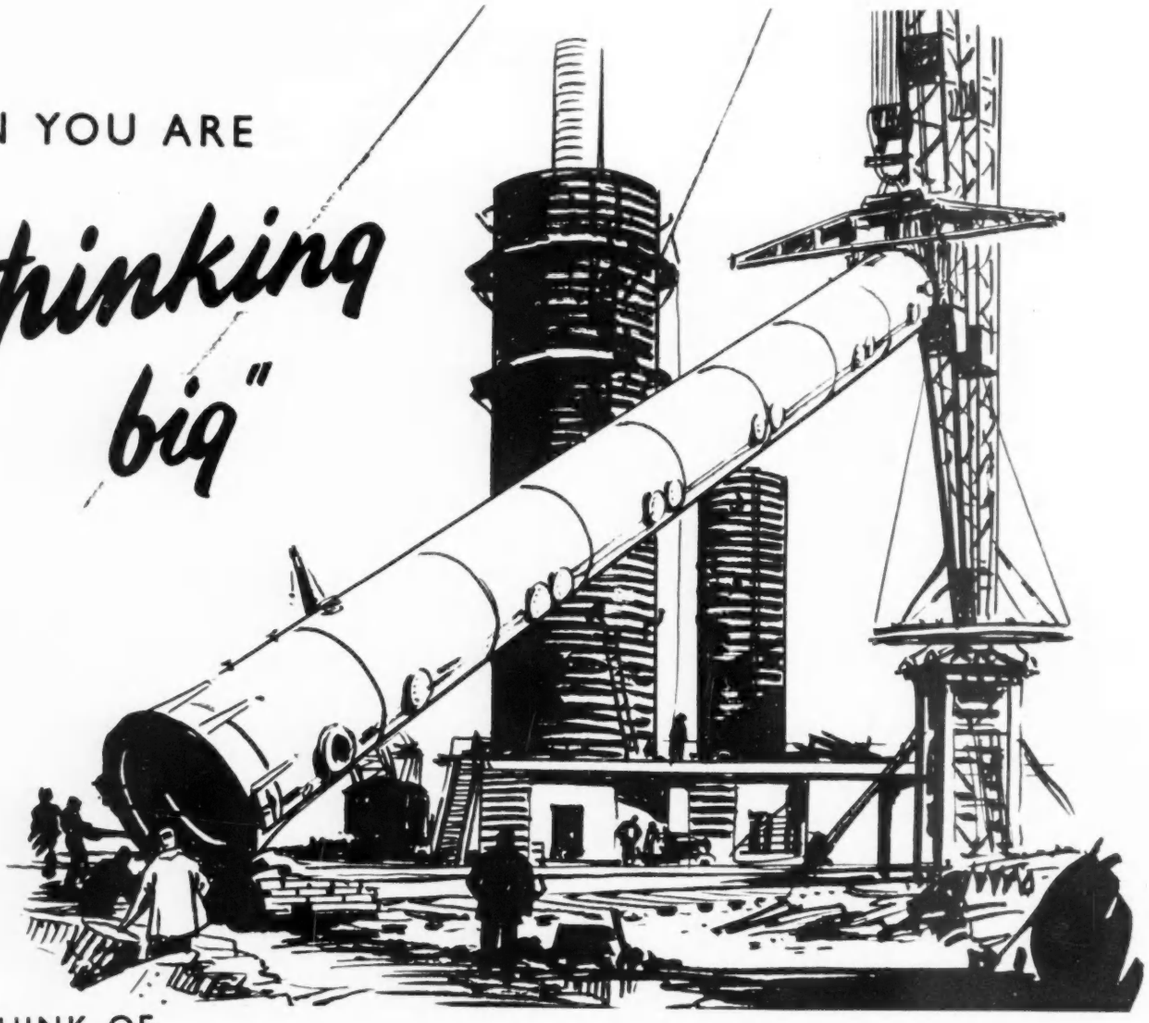

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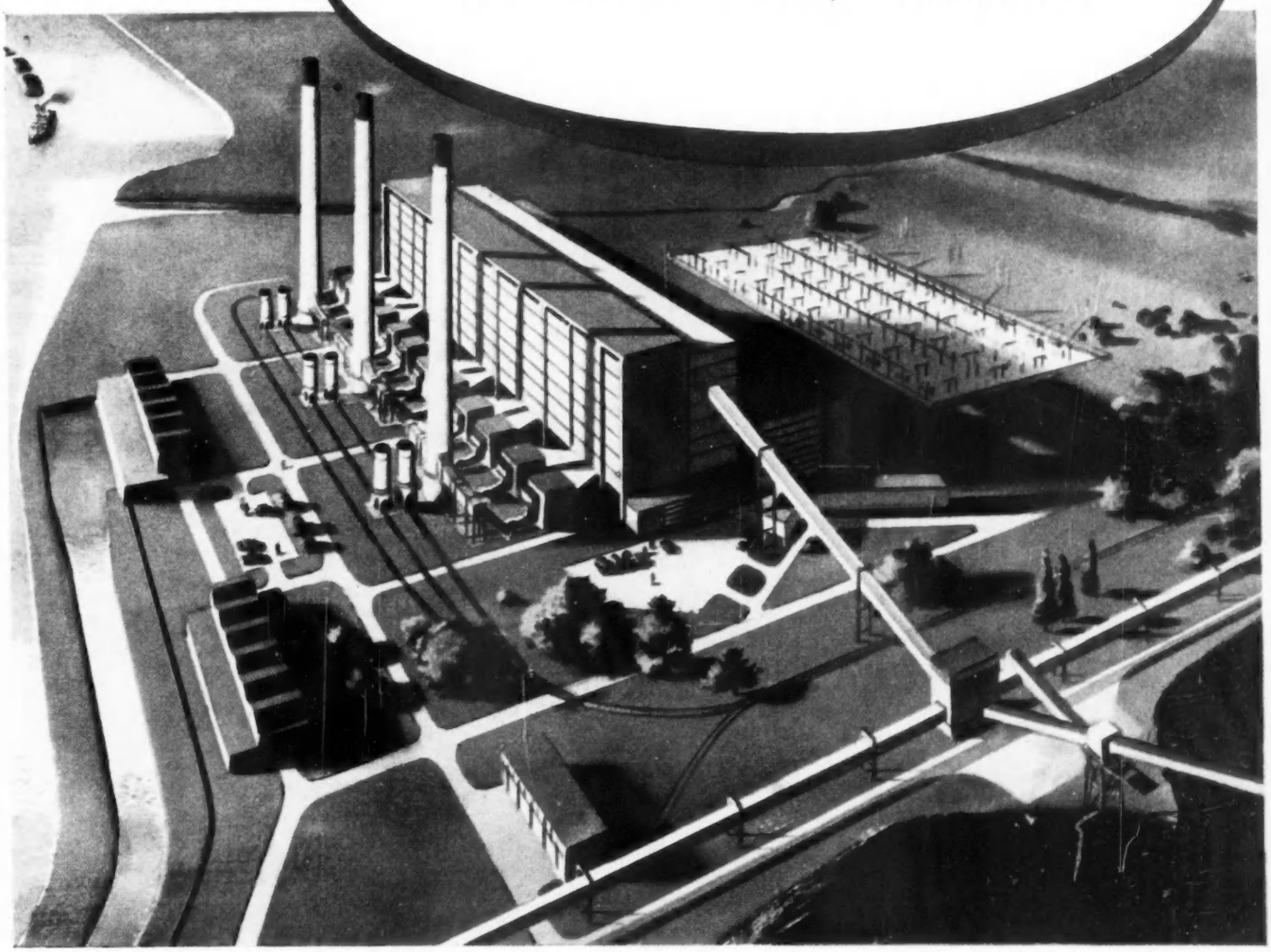
Two 300 MW sets for Lakeview, Ontario



From an original drawing supplied by the Hydro Electric Power Commission of Ontario

THIS artist's impression shows the Lakeview Generating Station now being built beside Lake Ontario. With its planned capacity of 1,800 MW, it will be one of the world's largest thermal-electric plants. Two 300 MW turbine-generators have been ordered from AEI and the first will be installed in 1963. These generating sets, like all AEI equipment, will incorporate advanced design based on long experience.

The AEI turbo-generators for Lakeview will have hydrogen-cooled rotors, and the system of water cooling of stator windings first developed by AEI engineers. The four-cylinder single-axis turbines will operate at steam inlet conditions of 2,350 psig and 1,000°F, with reheat steam at 1,000°F.

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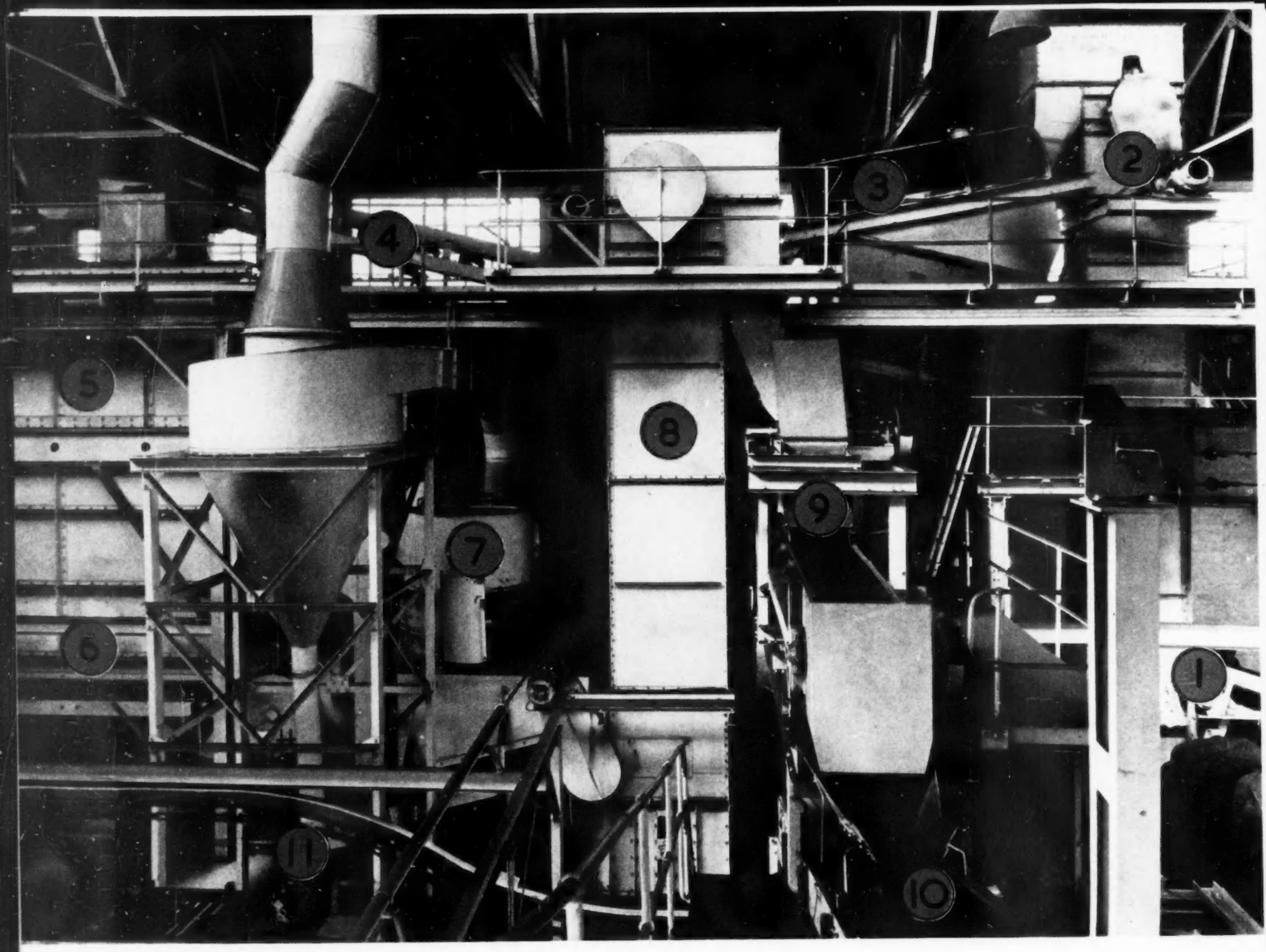

The illustration shows that part of a **MORRIS** foundry sand and mechanization plant which re-conditions knocked-out sand. At **1**, sand coming from the knock-out via an apron plate and belt conveyor passes beneath a magnetic separator (to remove tramp iron) and falls into the boot of a belt-bucket elevator, **2**, discharging into screen **3** onto belt conveyor **4** which in turn discharges into sixty-ton storage hopper **5**. The flat belt conveyor, **6**, under the hopper, pours sand into the skip which feeds the mulling machine (known as the Speedmullor). This machine **7**, providing a rapid mulling cycle with close batch control, discharges the sand into belt-bucket elevator **8**. From thence, the sand proceeds via belt conveyors **9** and **10** to the moulders. The overhead chain conveyor **11** serves the core shop with sand and also takes the cores to the stoves and to the moulders.

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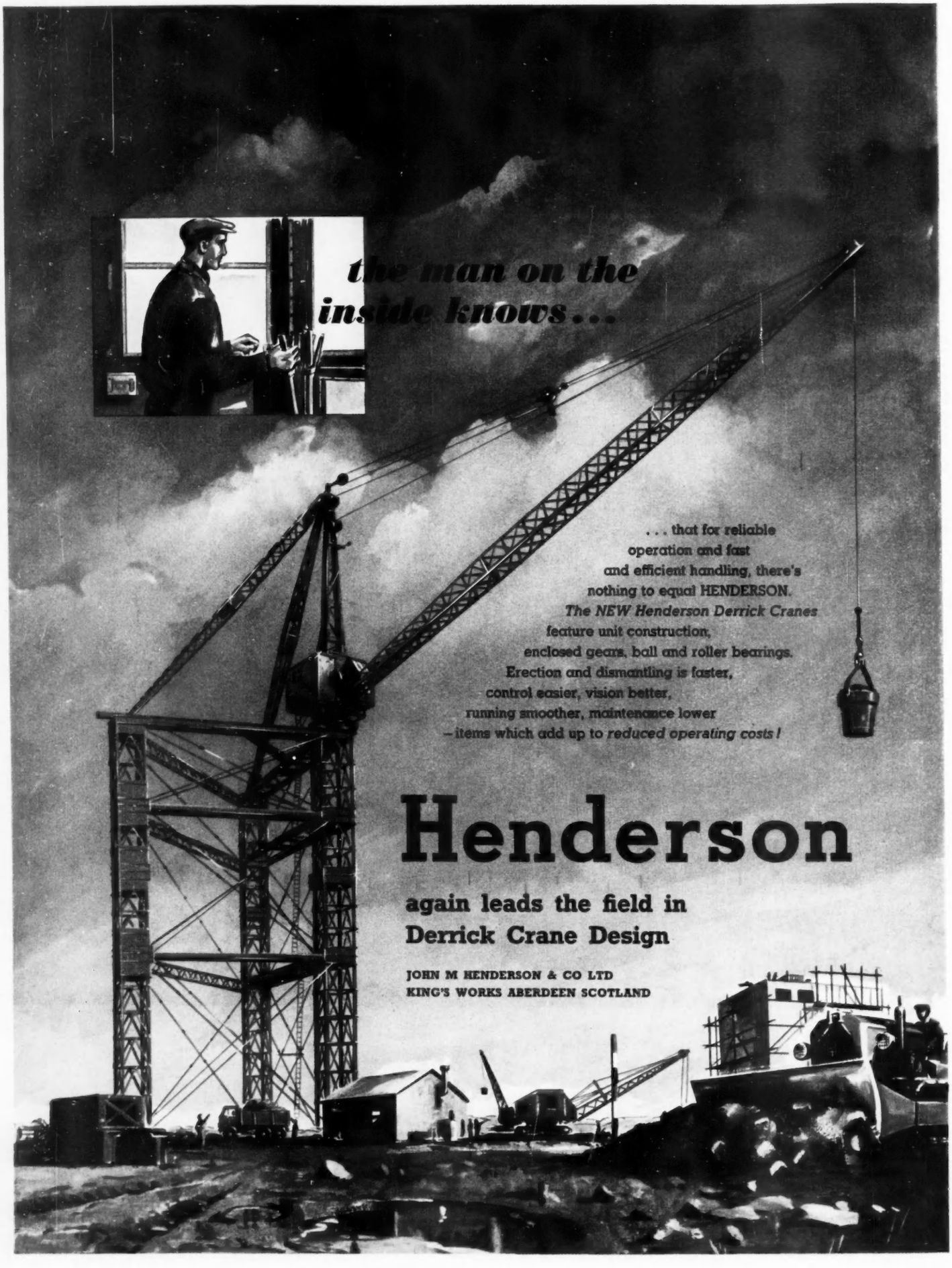
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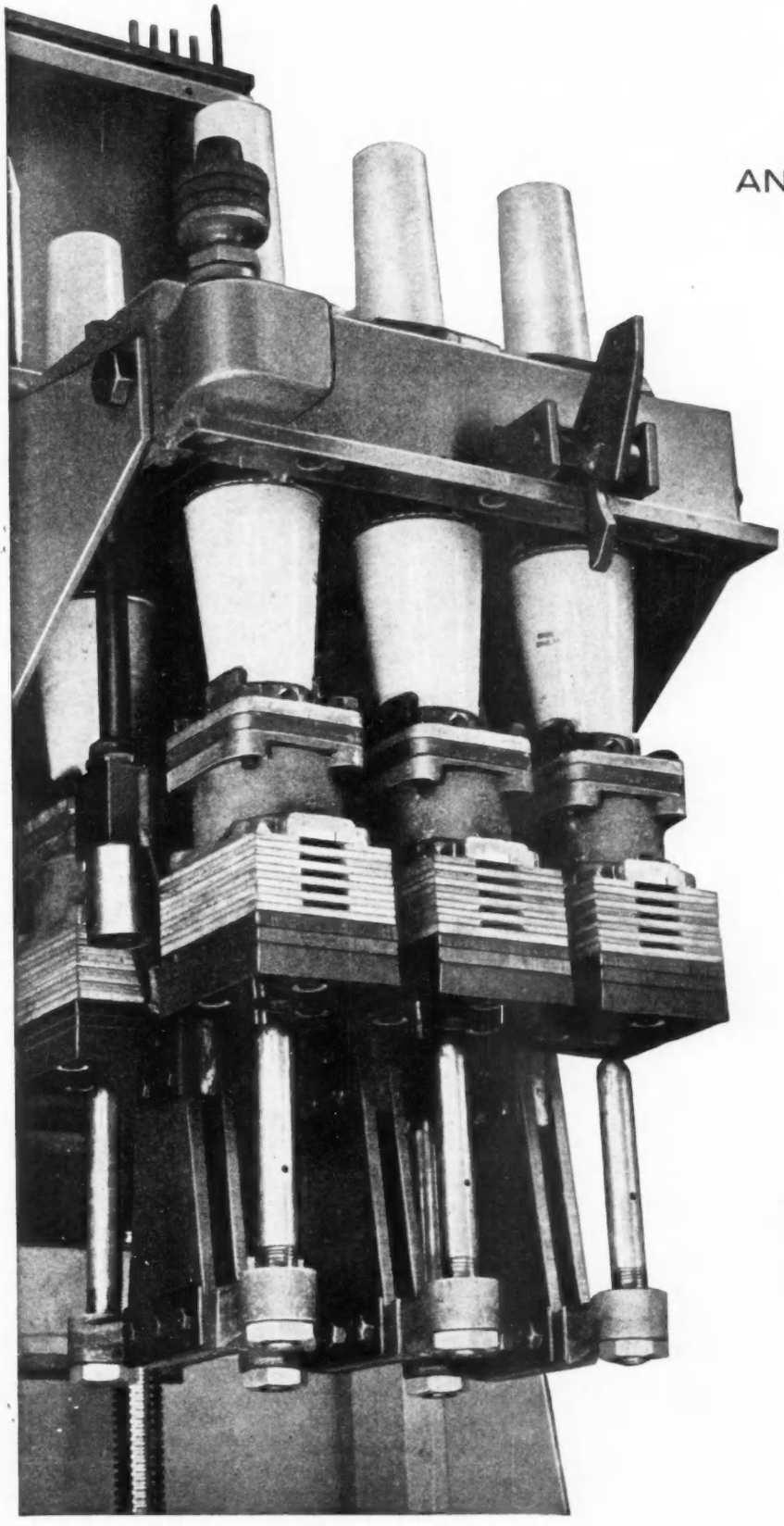

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AND MAKING SWITCHGEAR

You, as an engineer, know that there can be no sharp dividing line between designing and building. A good design incorporates experience gained in making, testing and installing similar equipment in the past. And, of course, it is also shaped by the experience of all sorts of people using the earlier designs under a variety of conditions that could not be simulated in any test laboratory.

To a long-established company such as Crompton Parkinson this process of feedback of information to the designer is fundamental. It is the guiding factor in those details that defy specification but which, in aggregate, have so profound an effect on reliability and performance.

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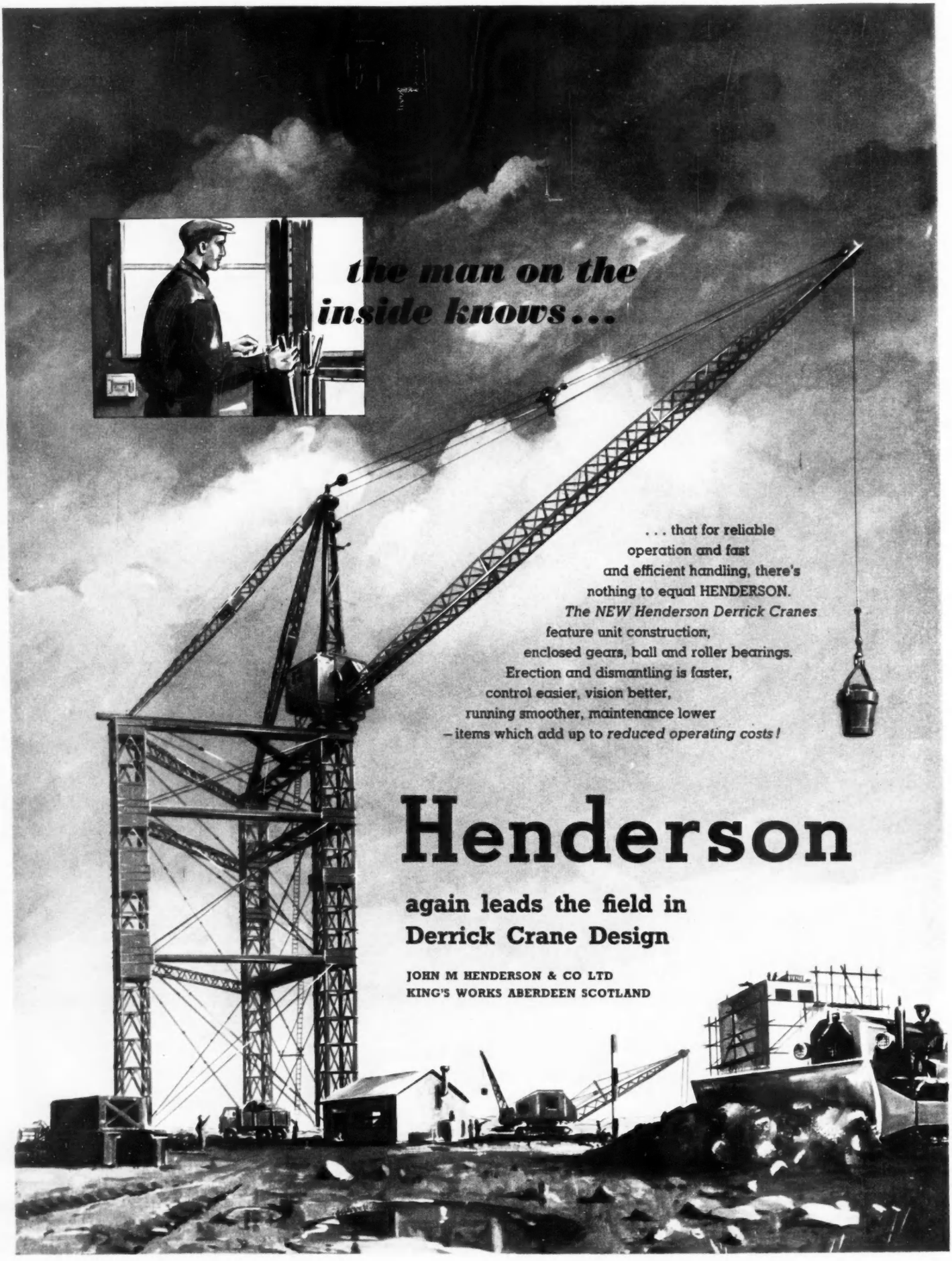
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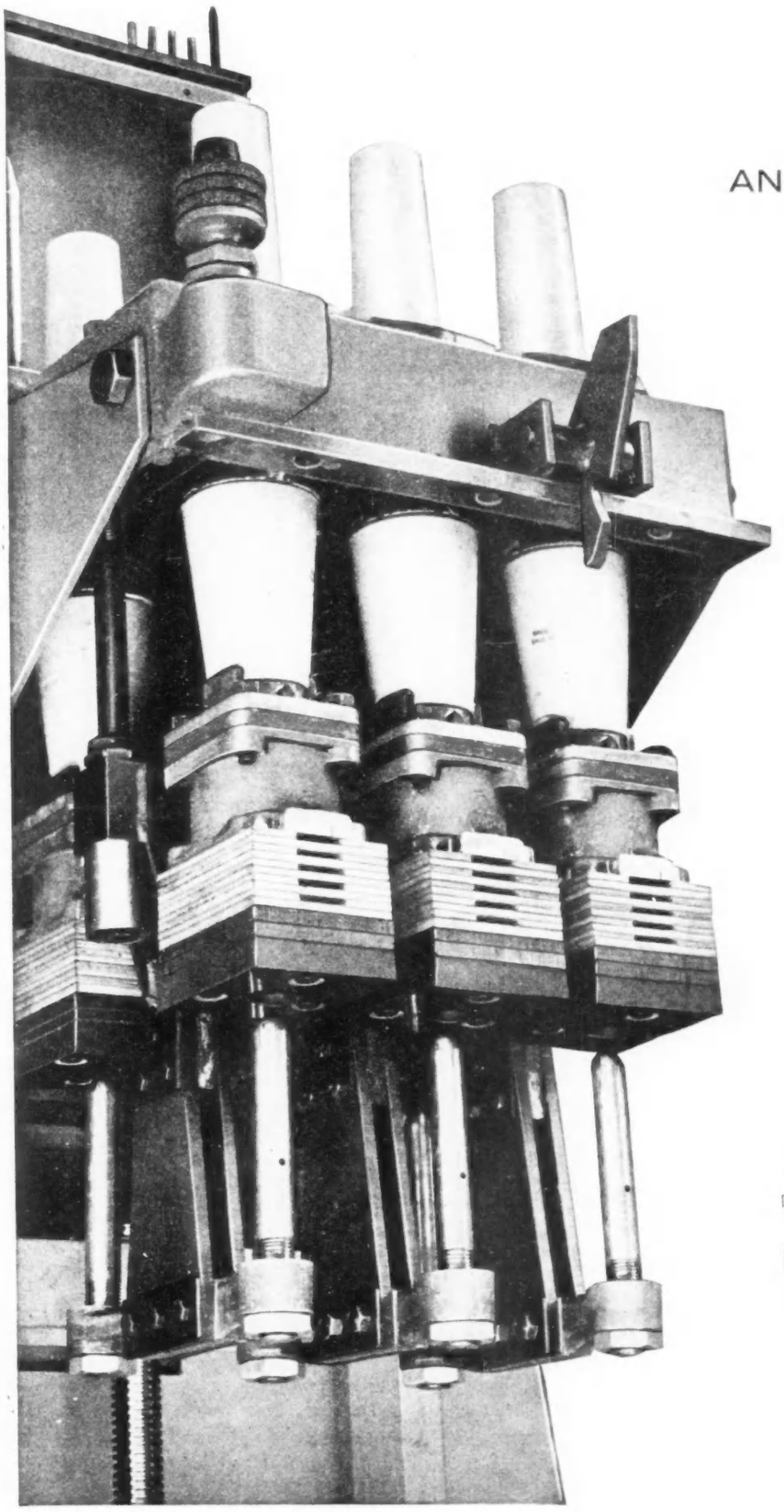

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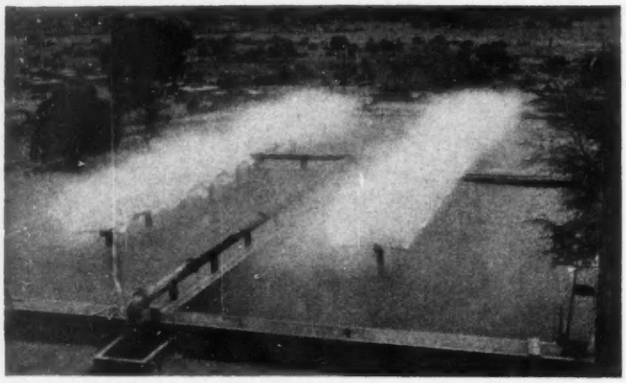

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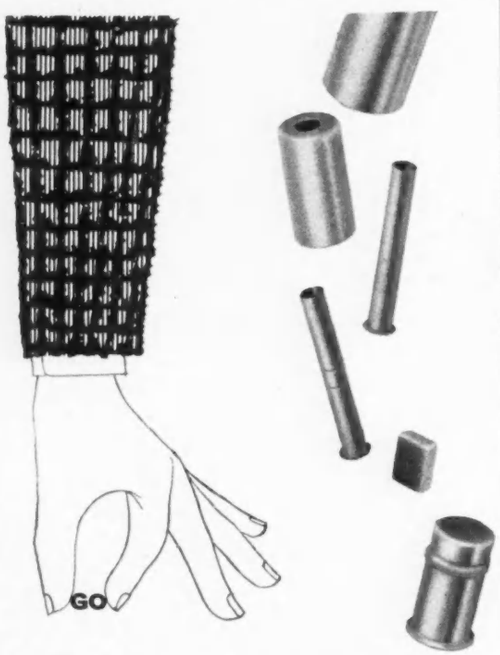

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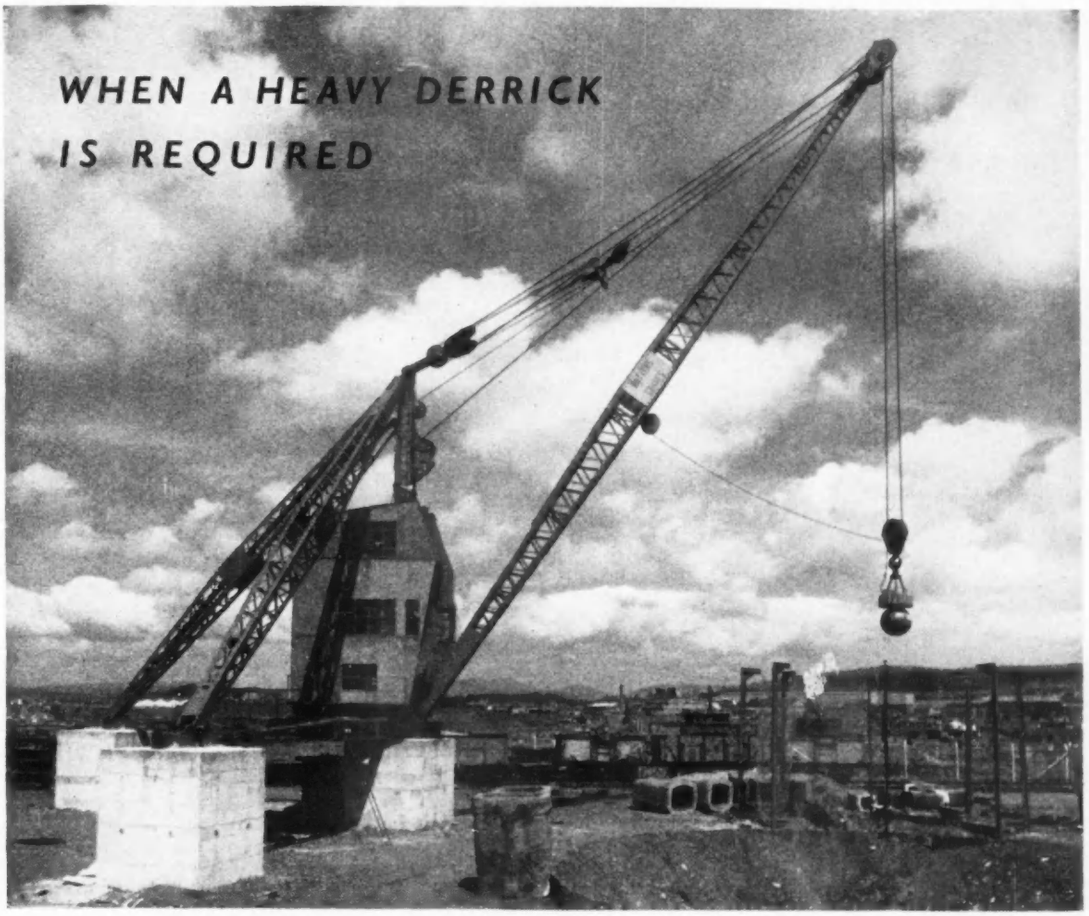

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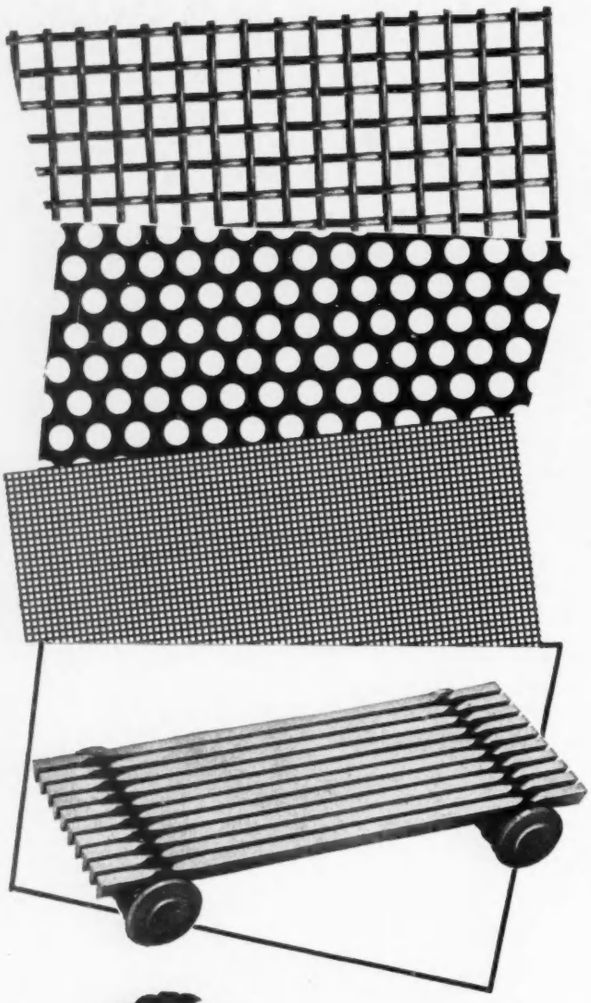

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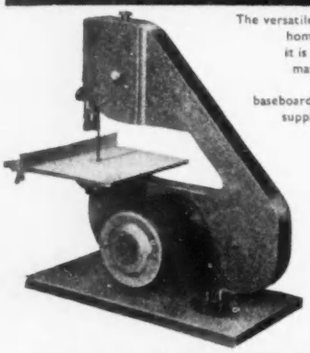

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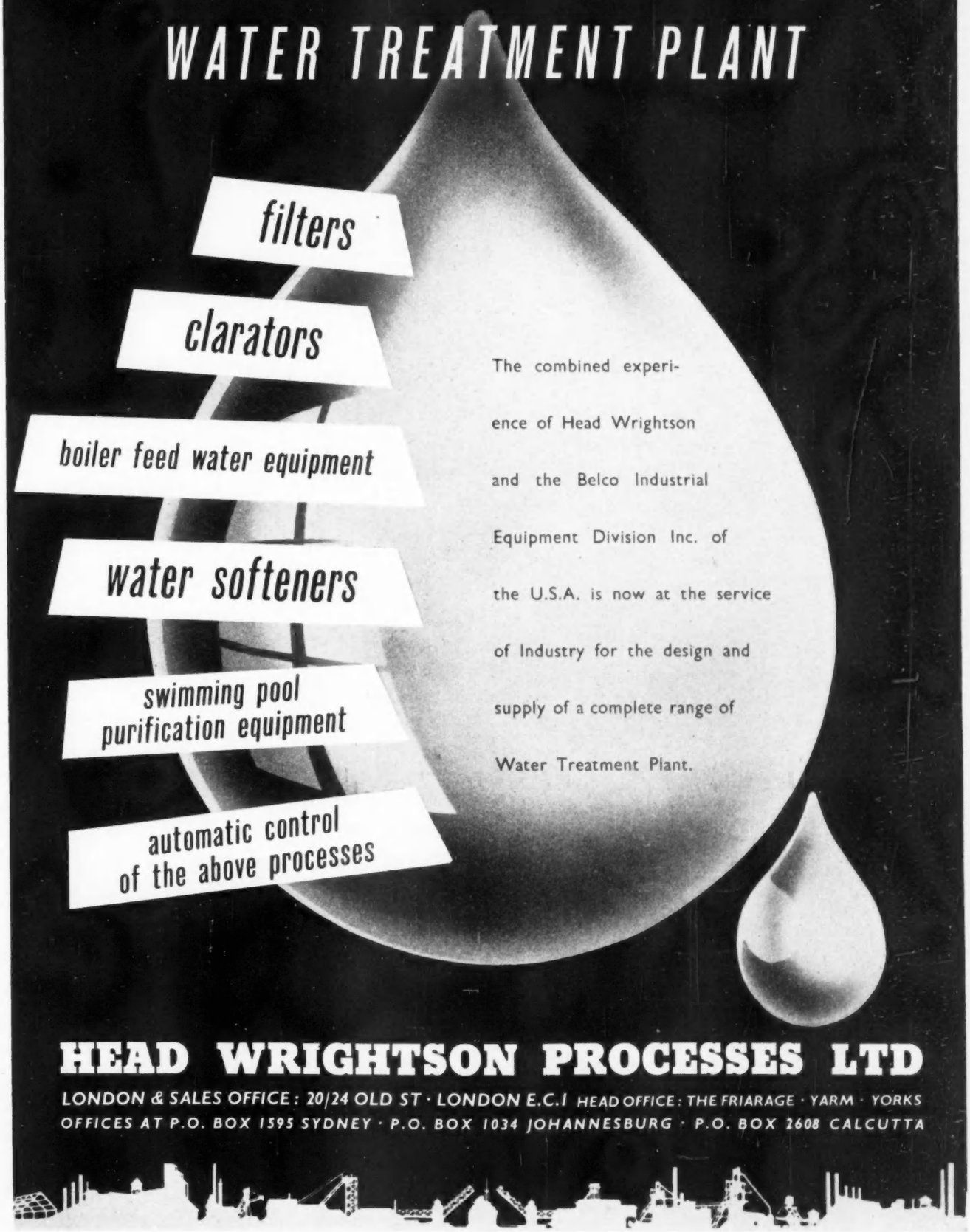

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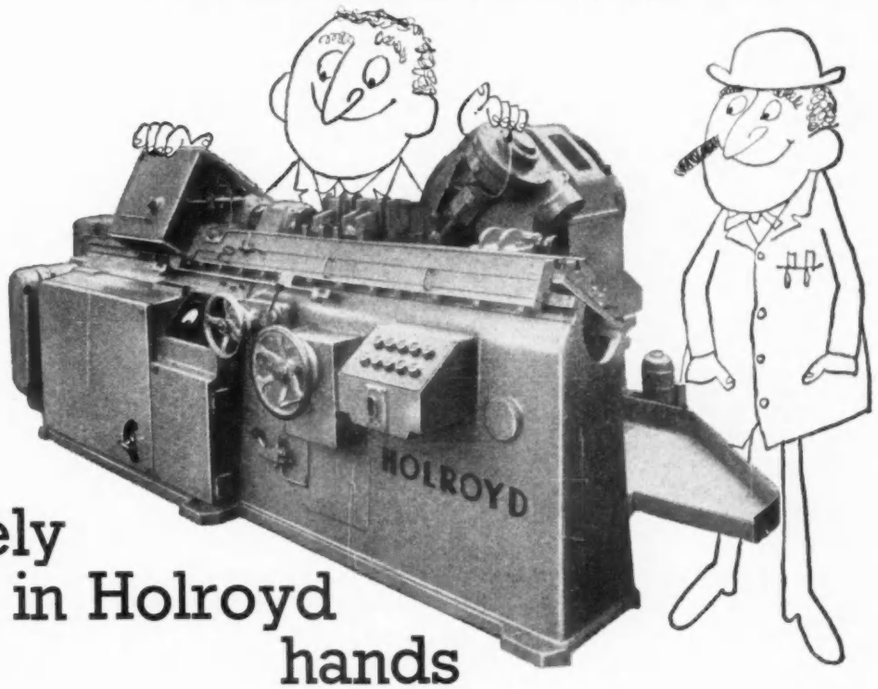

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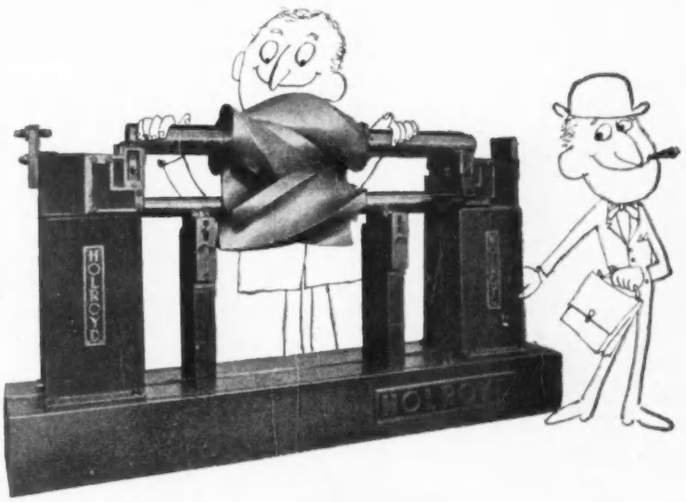

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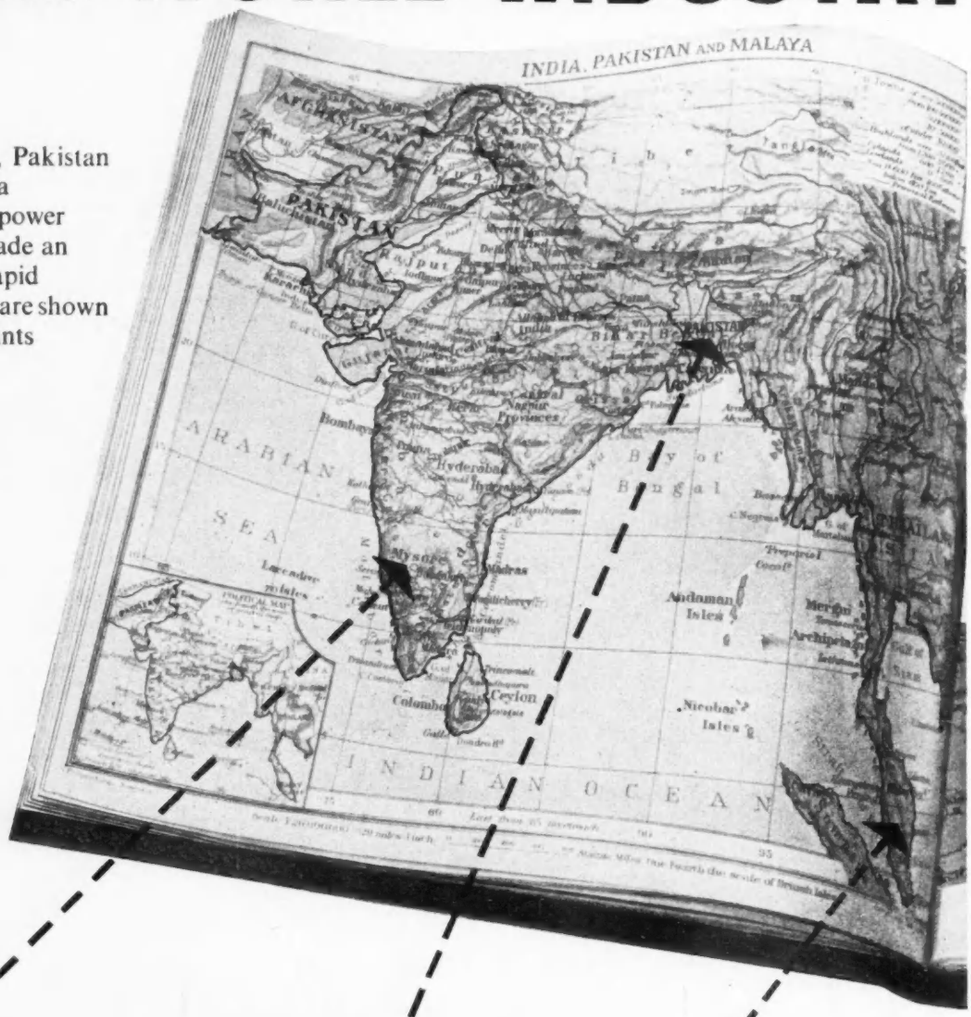

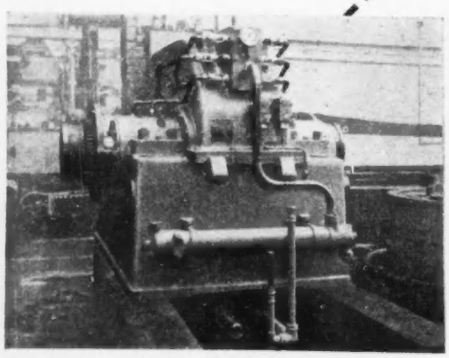

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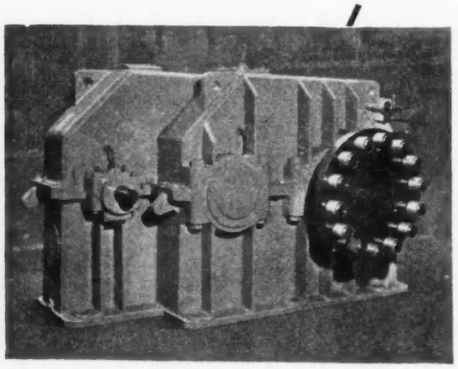
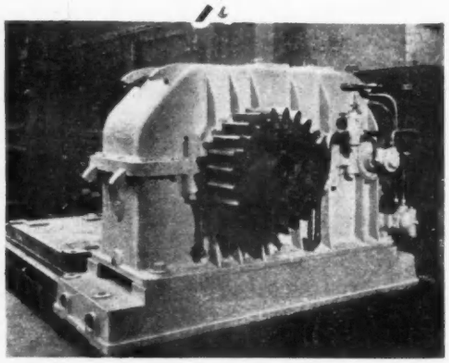


E. PAKISTAN. *A double-reduction, double-helical gear unit for driving sugar-crushing machinery. Several units of this type have been supplied to both Pakistan and Mauritius.*



MALAYA. *A gear unit driving a ladder-winch in a tin-dredging plant.*

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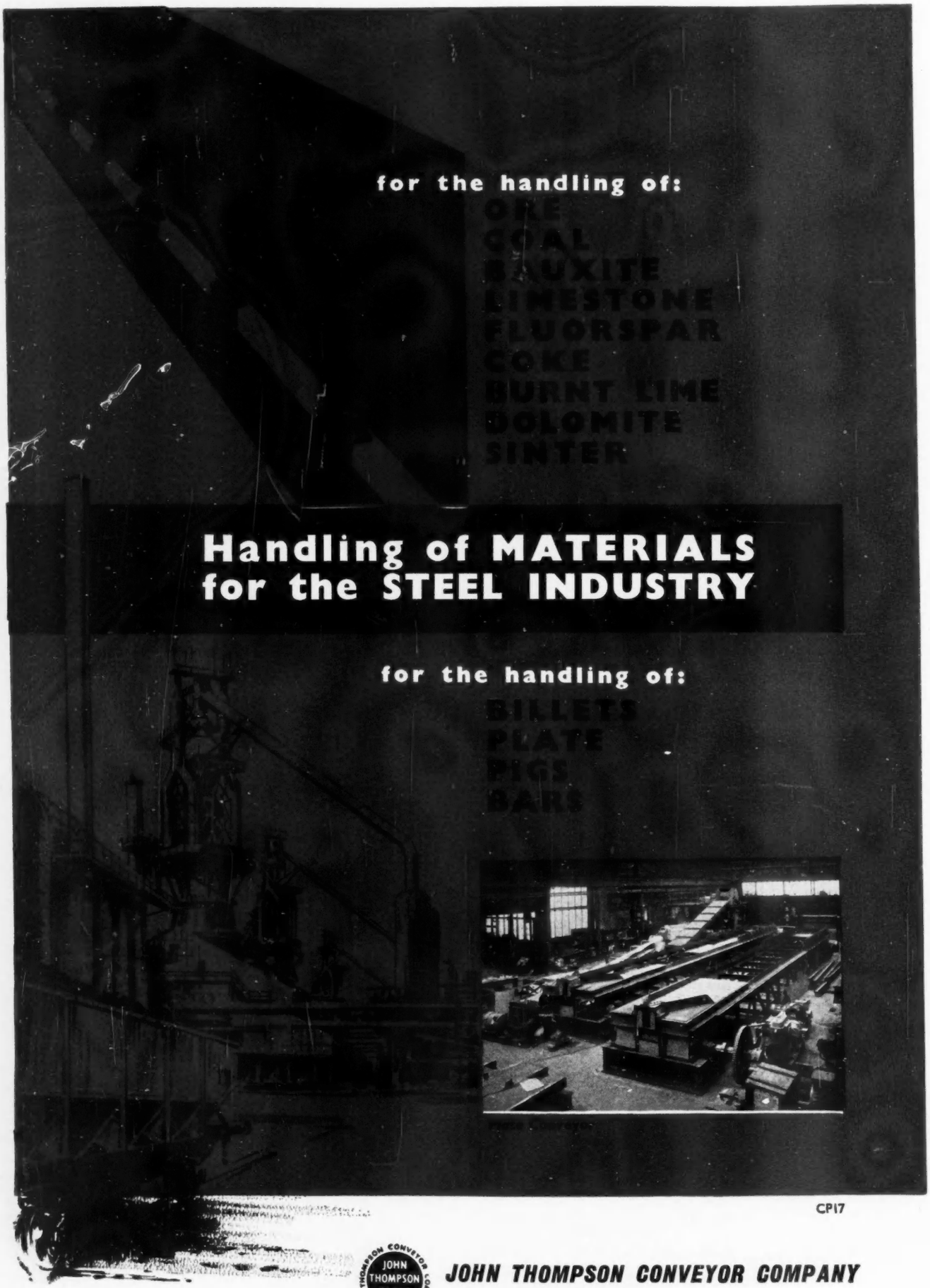

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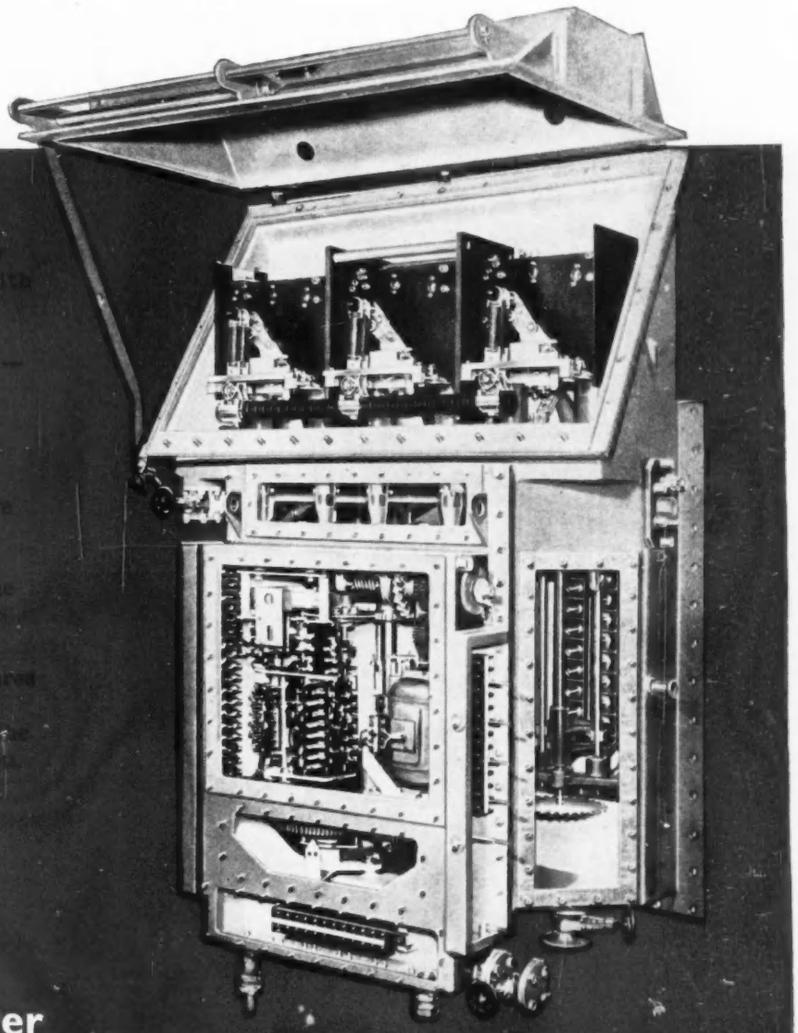

200,000 is a pretty impressive figure by any standard, but when it is linked with the number of operations carried out on the Ferranti D.C.3 Tap Changer using the same set of arcing contacts — and this is a proven test, not an estimate of performance — it is an achievement which will readily be appreciated by supply engineers.

The tap changer performed an average of 380 operations per hour at a rating equal to full load on a 10 MVA 33 kV System Transformer, running over the whole range step by step in both directions.

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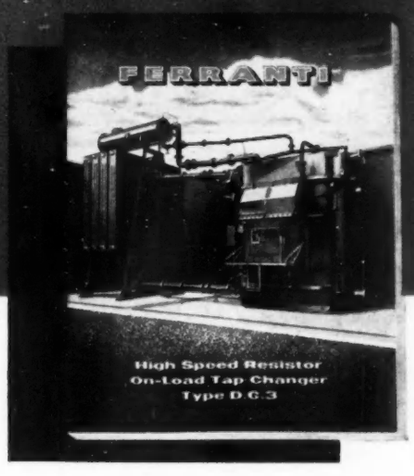

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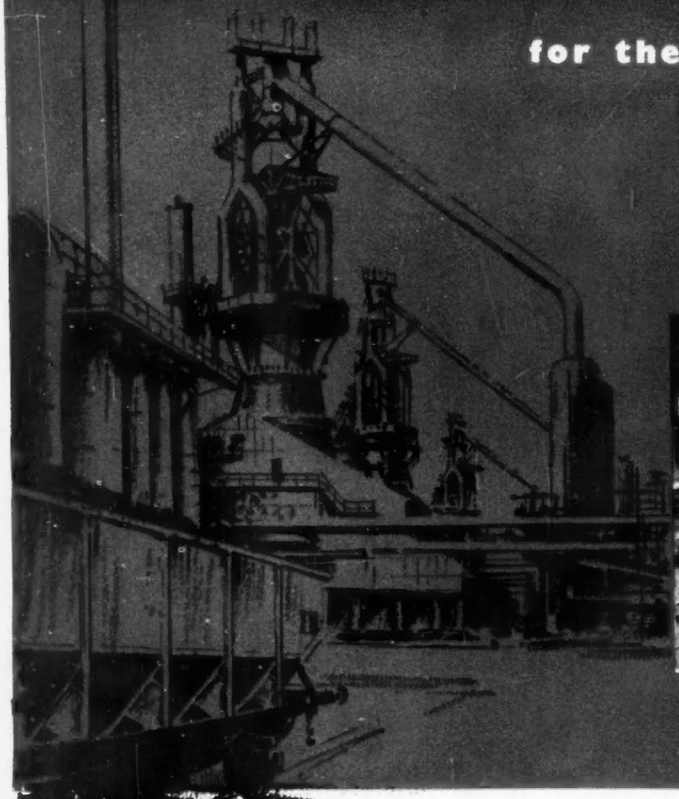

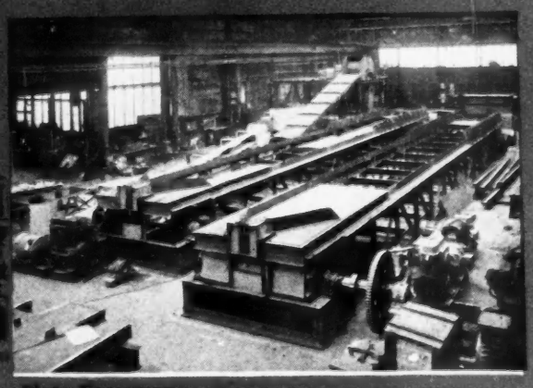

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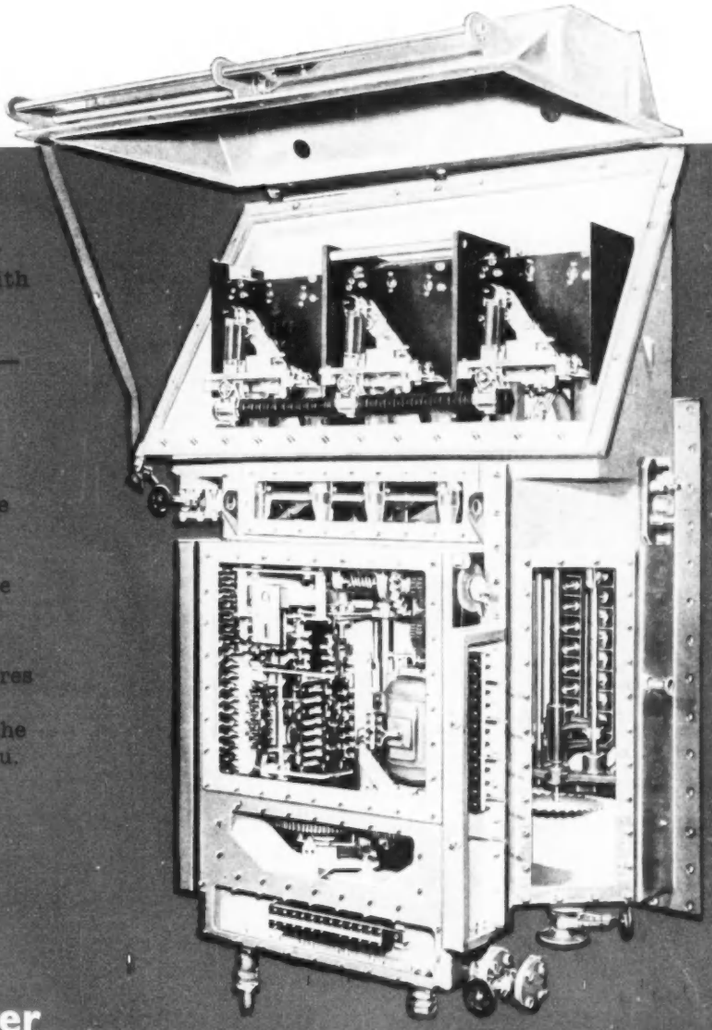

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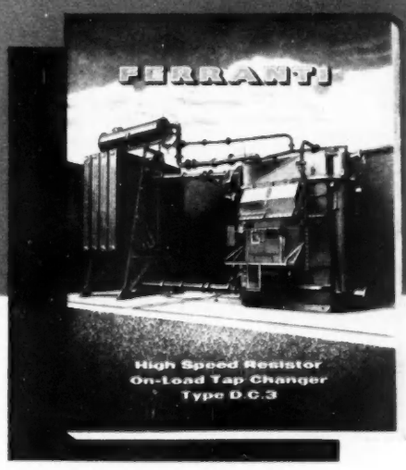
FERRANTI
High Speed Resistor On-Load Tap Changer Type D.C.3



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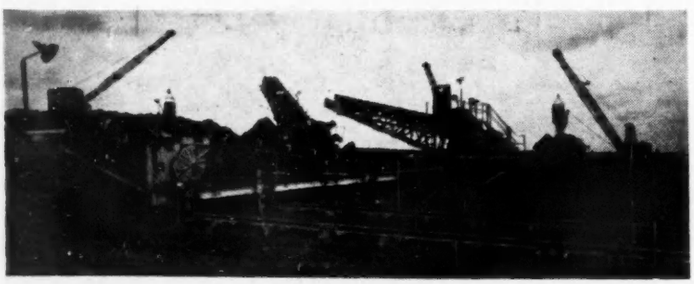
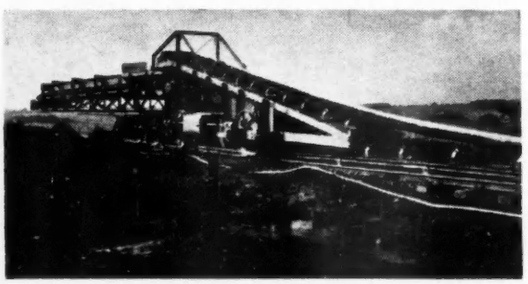


Mobile conveyors on the Great Ouse Flood Protection Scheme.



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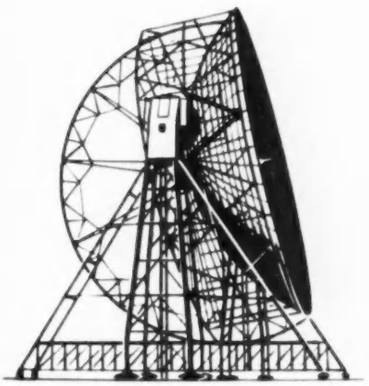

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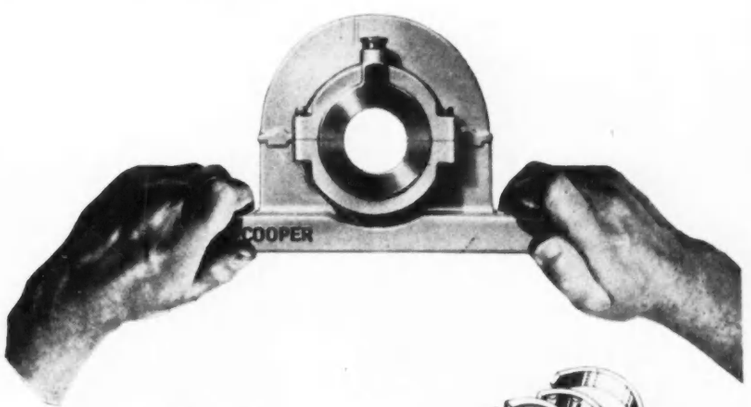

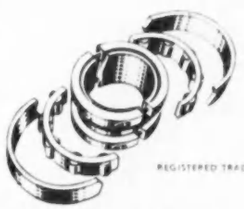

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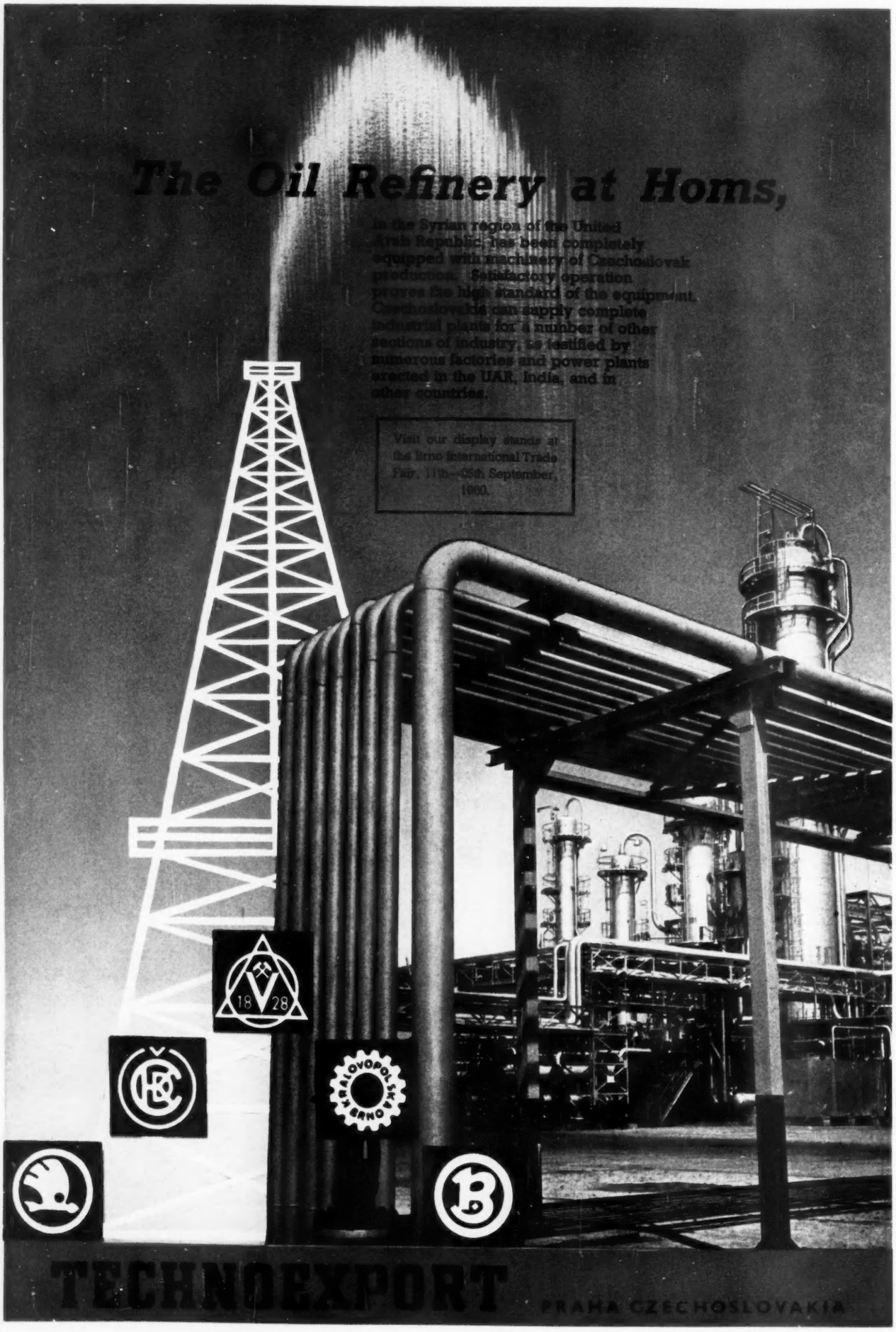
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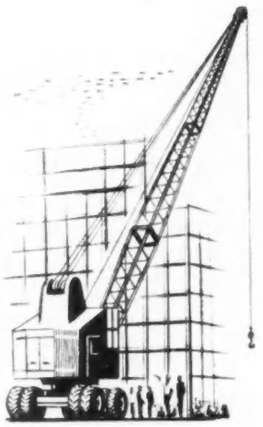

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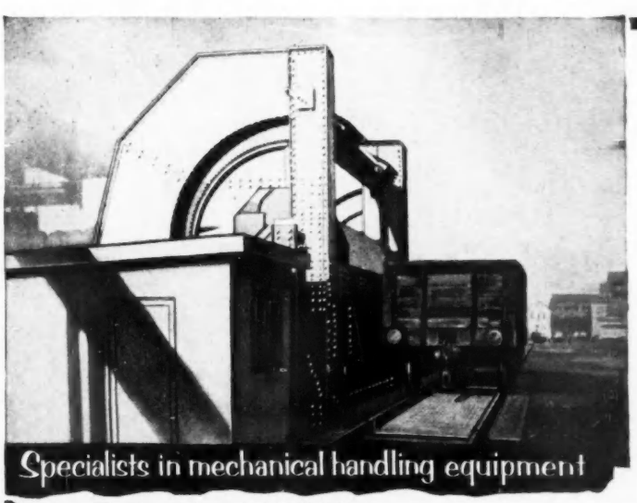

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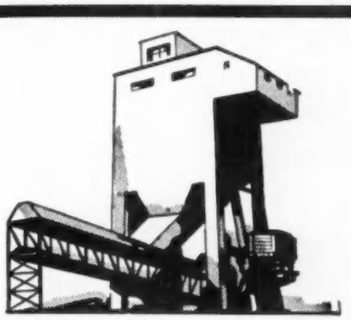

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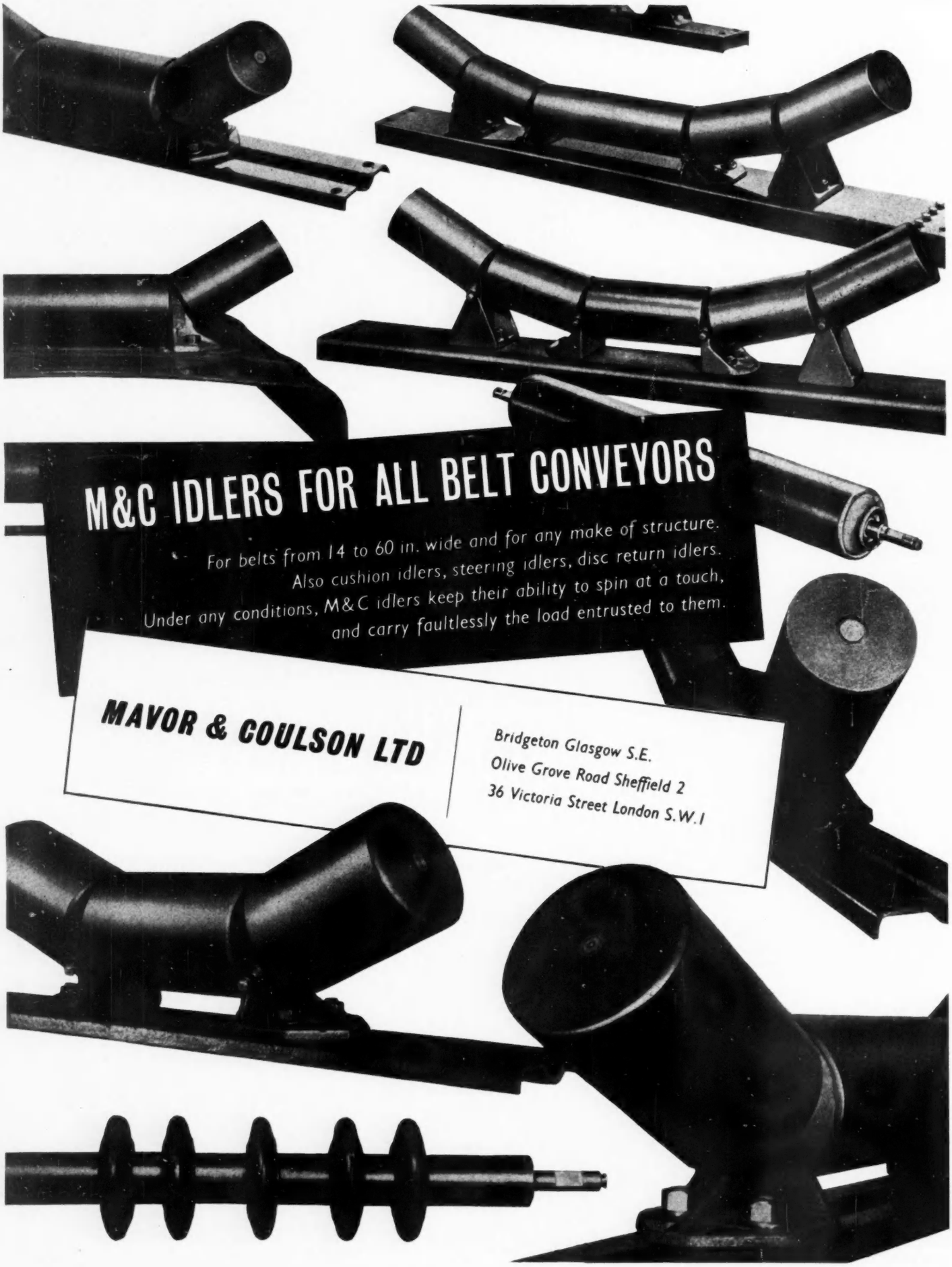
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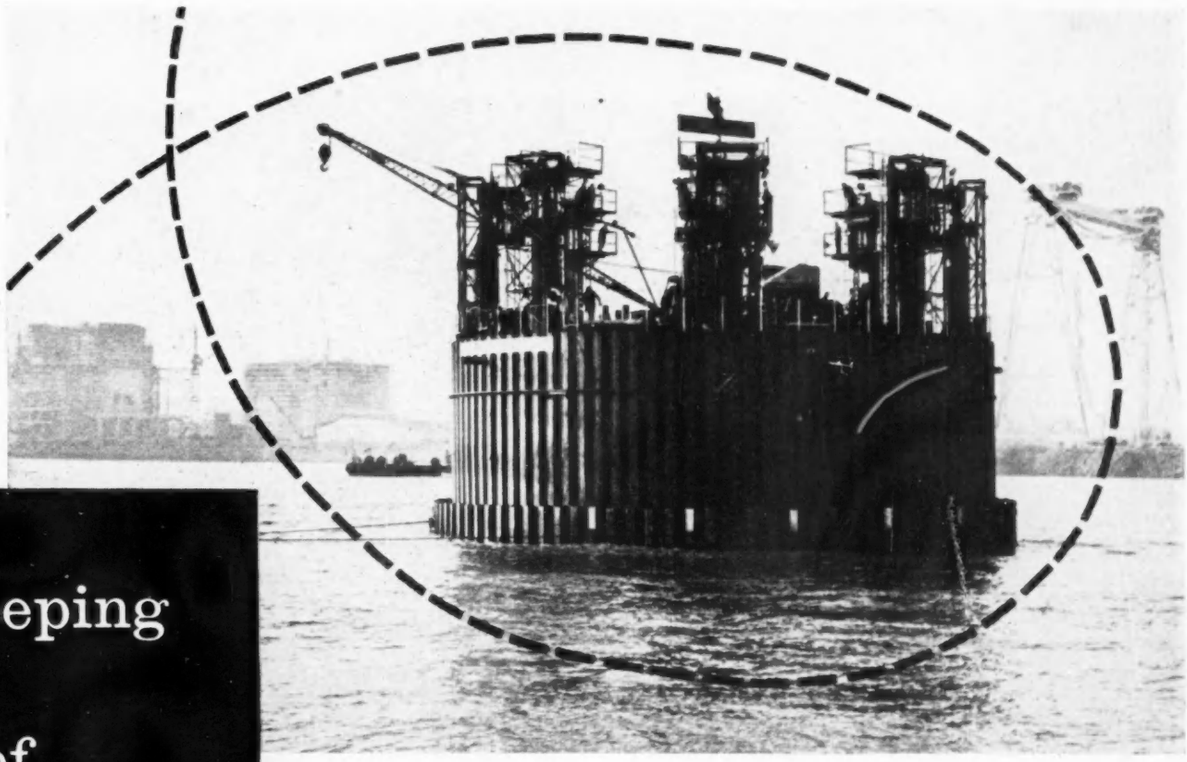

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Saunders-Roe strain gauge engineers provided a simple electrical system for measuring the loads in the spud legs.

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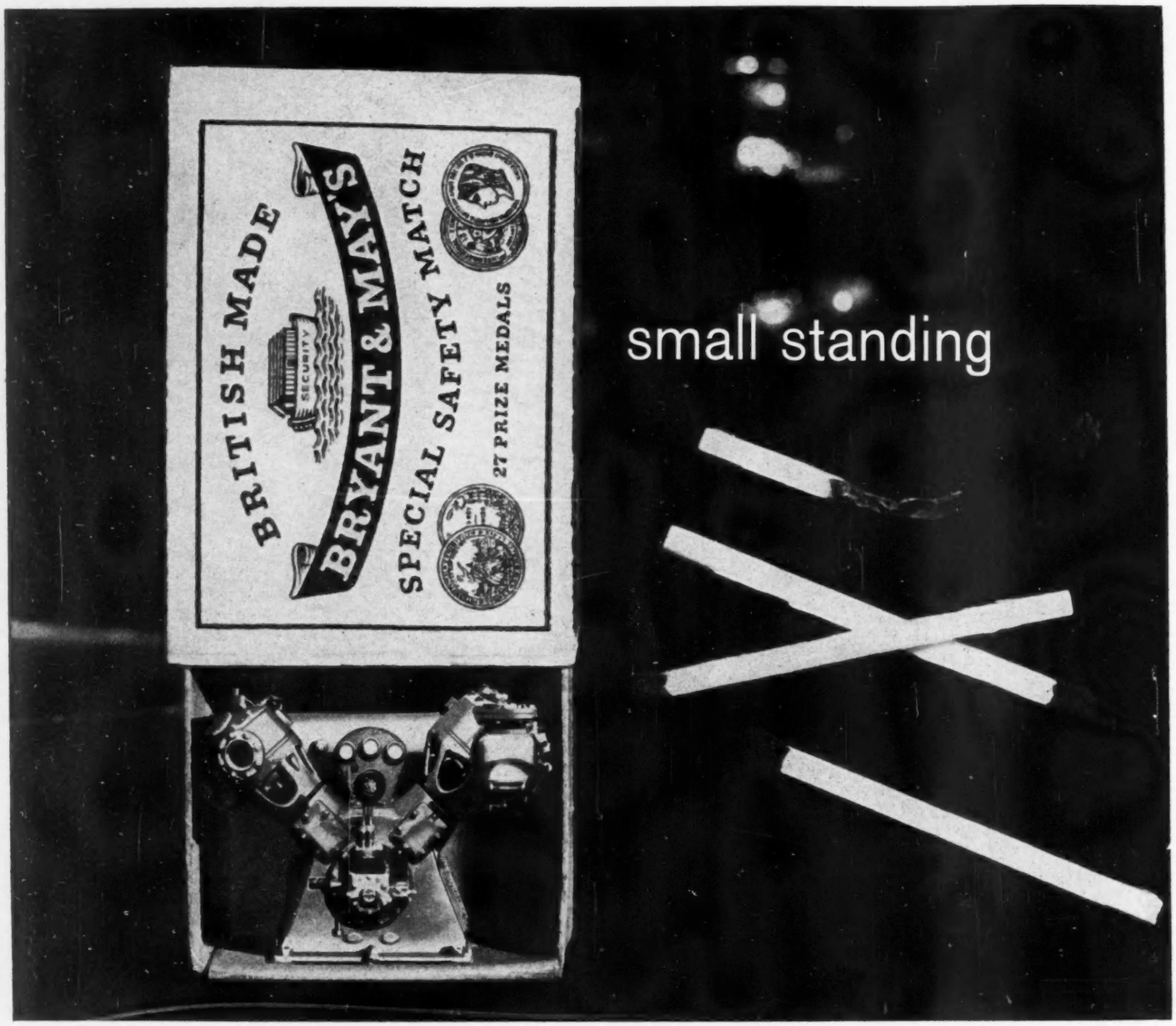

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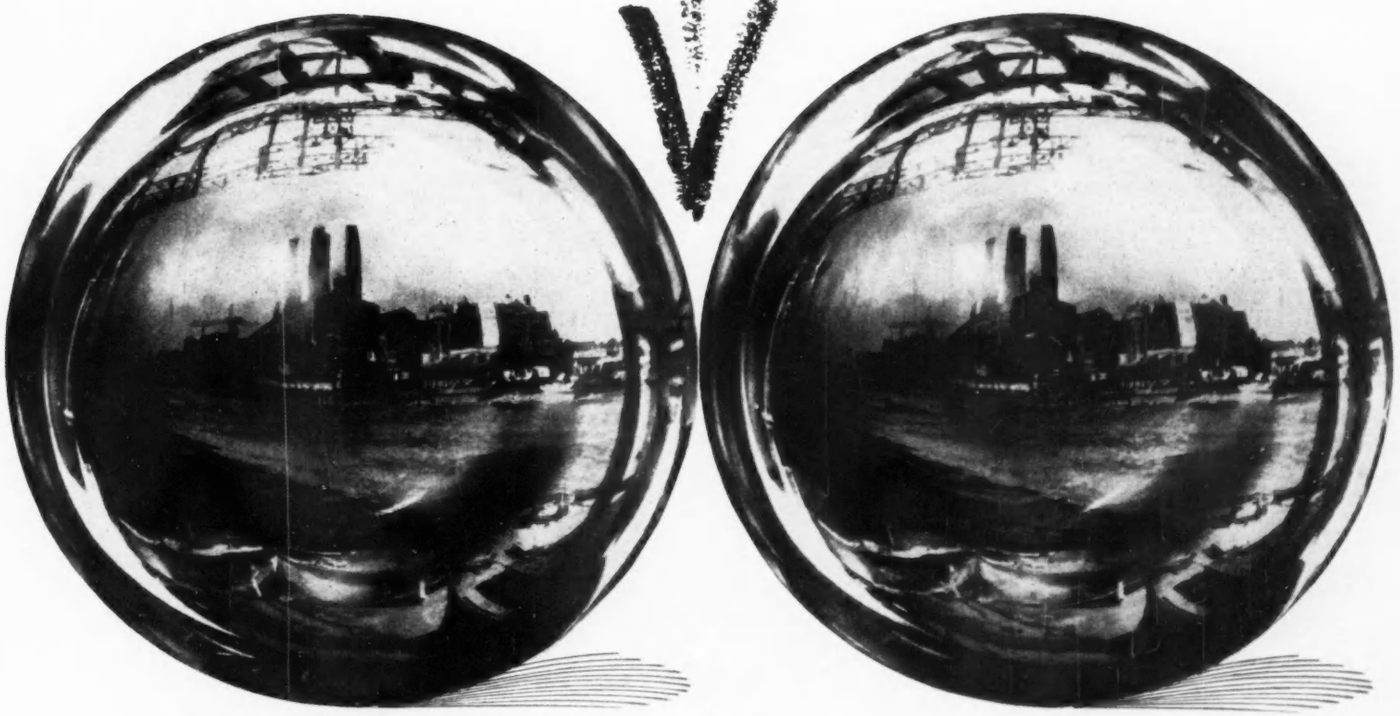

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'Power Vane' rotary units are water cooled for surface operation or air cooled with flameproof drive and complete protection equipment for underground service.

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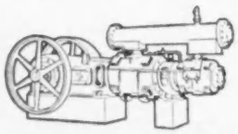
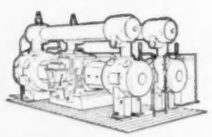
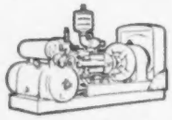


Class T straight-line, double-acting, single and multi-stage compressors for outputs up to 745 c.f.m. or pressures up to 2,500 p.s.i.



Class FE balanced-opposed multi-cylinder compressors for outputs up to 8,000 c.f.m. or pressures up to 3,000 p.s.i.



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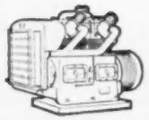

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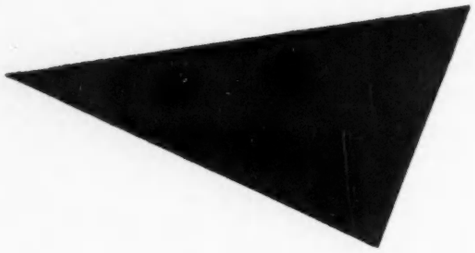


No Guesswork

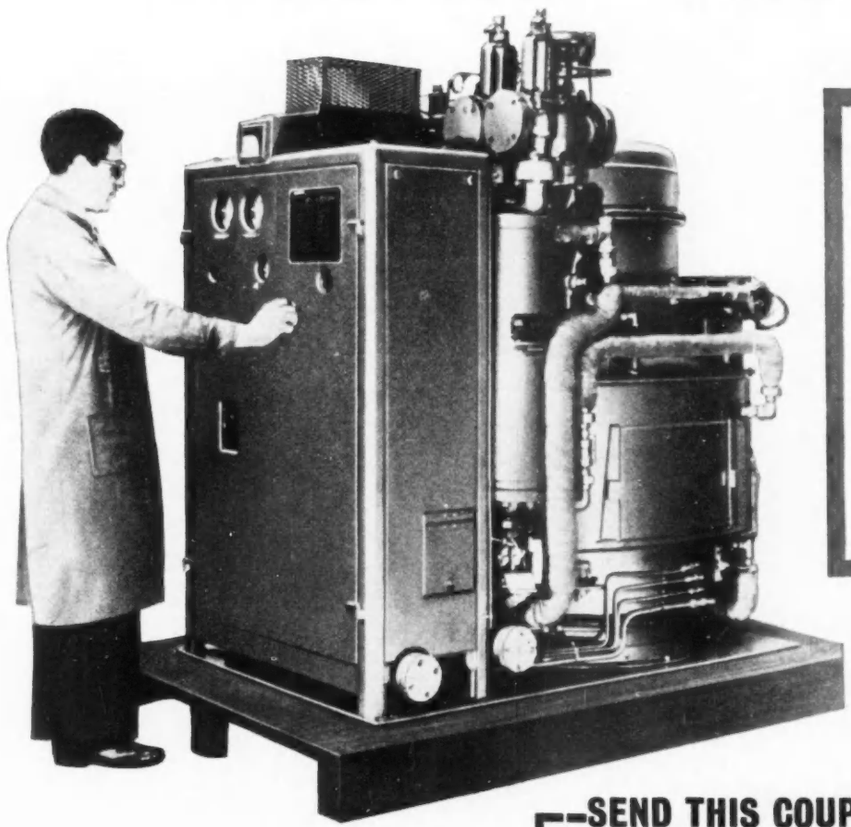
at West Drayton. Control of noise is an exact Science these days — we know because we practise it. Few Architectural or Industrial noise problems now exist for which an acoustically correct solution cannot be found. We know because we find them—and what is more, we warrant the results. Yet how many of our otherwise enlightened Architects or Industrialists know this simple truth, or realise just how much modern Acoustic Engineering can in fact achieve? Do you? If you are saddled with a noise problem and we of Sound Control Limited, Colneside Works, West Drayton, Middx., are sitting on the answer, why read further? Just ring West Drayton 3685.

For a 'package boiler' achieving 1,000,000 B.Th.U per cu. ft. output

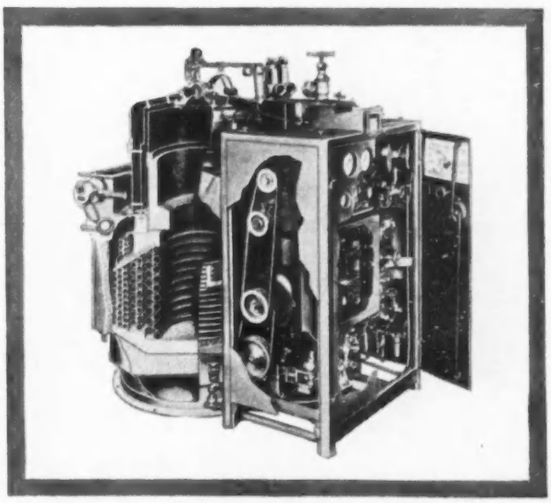
Inconel* HEAT-RESISTING ALLOY

Quick start-up and quick changes in output whenever required are the features of the compact, efficient Stone-Vapor steam generator. Working pressure can be raised in 2 minutes from a cold start! This requires an intense rate of firing, releasing up to a million B.Th.U. per cubic foot.

To meet the exacting conditions of service in this modern 'package boiler', Inconel heat-resisting alloy was chosen for the fire-pot and air-ring of the combustion chamber. This high temperature alloy was selected because of its excellent strength and resistance to scaling and oxidation at high temperatures.



The fire-pot and air-ring of the Stone-Vapor steam generator are both of Inconel heat-resisting alloy.



Cut-away view of 'package boiler' produced by J. Stone & Co. (Deptford) Ltd. It is ideal for use in ships, trains, factories, laundries, and wherever high-quality steam is required economically.

* *Trade Mark*

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During the last 60 years, Wakefield lubricators have kept abreast of the changing needs of industry. The DP 60 represents the experience of these years. It is an instrument of precision for feeding oil against pressures up to 1000 p.s.i. It can be operated by the plant it lubricates on reciprocating or rotating drive. The flow of oil is automatically controlled by the 'start-up and cut-off' of the machine. Efficient lubrication is combined with economy in oil consumption.

ADVANTAGES OF THE DP 60

Welded steel construction gives strength with low weight ratio.

Each feed can be regulated independently.

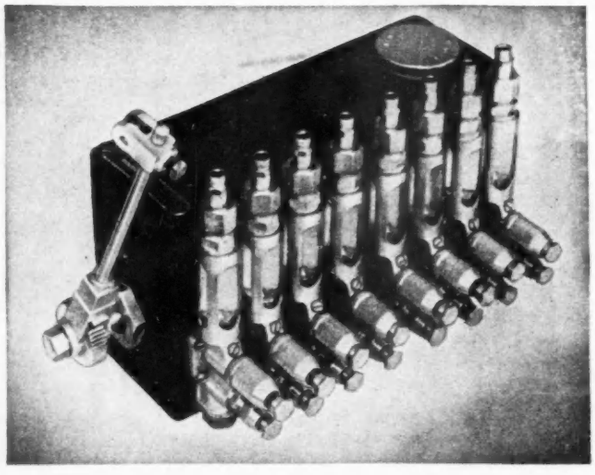
Complete pump unit can be removed and replaced in one assembly.

Patented quick release cap minimises oil contamination.

Up to 32 feeds can be fitted.

Large oil reservoir ensures long working periods between topping-up times.

Built-in perspex oil gauge on the oil reservoir.



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ENGINEERING Impact

of Wasting Time Money and Capacity

IF THERE were a 20th century equivalent of Gilbert and Sullivan there is no doubt they would be unpopular in Whitehall. But if they were to take for a plot the sort of antics uncovered by the Committee of Public Accounts their productions would be sharply ctiticised for reaching improbable levels of the fantastic.

Yet what the committee has discovered in the alleged financial control of guided missiles is simple fact. In general, says the committee, the initial estimates have been even less realistic than those for aero engine and aircraft development.

Misguided

The Treasury approved one development contract for a guided missile for the Navy, back in 1948. The estimate then was of a cost between £1 million and £1½ million. Currently, 12 years later, the estimate of the direct cost of developing the missile and its guidance system is £40 million. The total all-up cost will be about £70 million, including Admiralty developed shipborne radar. The committee referred to two other missiles where the current costs are many times more than the first estimates.

Apart from the pain and suffering to taxpayers, does this matter?

Is there a connection between the collapse of the defence policy and the Mad Hatter activities on the financial side?

There is. And it is a simple one.

A defence system does not exist in a vacuum. If there was no potential enemy there would be no willingness on the part of the voter to be endlessly taxed. And the value, or otherwise, of a method of its defence is in strict relation to what the possible opponent is getting up to. Hence the decision to abandon Blue Streak because of the vulnerability of fixed bases to Russian long range rockets.

Misleading

However essential it may be to have a proper estimate of the time that achieving defence targets will take, it is unlikely that such an estimate can be made if it is not even possible to tell the cost without being out by as much as a factor of twenty.

The effect of all this on the engineering industries is plain enough. Misleading estimates result in misguided use of materials, of capacity of engineers and scientists.

Projects that will prove too costly in relation to their work are started. And, in the end, what is produced is about as useful as a 1960 racing car engineered to the racing formulae of 1959.

Not only does the nation suffer in that its defence system is either inappropriate or abandoned. Its home market has to be assaulted in an effort to compel further export efforts which could have been made with the industrial potential led astray by inaccurate forecasts.

Mechanical Aids for Coal Burners

For coal to compete effectively with oil and electricity it must be given the same automatic equipment that has come much more easily to its competitors.

The annual report of the British Coal Utilisation Research Association shows that advanced work is being done at a number of key points. Of special importance to industrial boilers are the inquiries into the mechanical handling of small coal. Using a model bunker and with an experimental bucket elevator it has been confirmed that very fine particles, and the high moisture content which they bring, are the primary cause of impeded flow. The elimination of the fine particles leads to a valuable improvement.

Plainly the increasingly large and numerous blocks of flats in London and elsewhere are fair game for competition between fuels. BCURA have intensively tested a small chain-grate stoker which is being developed for solid-fuel central heating in such buildings as blocks of flats. The automatic control system of this equipment makes it possible for a range of differing coals to be burned. A satisfactorily low combustion rate can be used when needed. Over the whole range of burning rates efficiencies of over 75 per cent have been attained, with negligible smoke, dust or grit emission.

A field trial unit of the boiler has been installed in a London block of flats.

The special knowledge of the association's staff has led to a wide variety of research work in related fields, from research on deposits and corrosion in water-tube boilers to the production from coal and possible future uses of chlorofluorocarbons and, by an agreement with the United Kingdom Atomic Energy Authority, research into the structure and reactivity of graphite used in moderators for nuclear reactors.

Aircraft Icing and Meteorology

The third annual conference on Aircraft Icing Protection, sponsored by D. Napier and Son Limited, which was held at Luton (Beds) Airport, was attended by a record number of delegates, including Russia for the first time. Jet engines are particularly vulnerable to icing conditions as ice forming on the engine intake can detach itself in lumps, enter the engine and damage the compressor blades. Nor can aircraft capable of continuous flying above cloud level escape icing, because in all probability they will have to pass through one or more cloud layers at icing temperatures during ascent and descent.

Furthermore, an aircraft flying for a long period at high altitude becomes "cold soaked," so that even on a hot summer day frost forms on the wing, particularly on the underside, as soon as the aircraft lands. A distinction must therefore be drawn between "anti-icing," which is performed by the aircraft's own protection system of heating elements or pulsating surfaces, and "de-icing," which has to be carried out on the ground to render the aircraft "clean" before taking off again. New but expensive de-icing compounds now being tried at London Airport really combine both functions, by leaving an anti-ice coating on the sprayed surfaces.

Mr. R. F. Jones of the Meteorology Office, in reply to a question, gave no hope of escaping the problem for he stressed that it was very difficult to forecast occurrence of clouds or their icing characteristics over a long flight route or for a lengthy period.

The chairman of the conference, Mr. H. G. Conway of Short Brothers and Harland Limited, summarised its main conclusions by listing the needs on which further research should be concentraded, as follows:—

(1) Need for exchange of meteorological experiences on an international basis.
(2) Need for more trials, including large scale wind tunnel tests, special test aircraft like Napier's modified Lincoln bomber, and full flight trials.
(3) Need for reliable ice detector instruments, to provide automatic initiation of an aircraft's protection system immediately icing conditions are encountered.

of House Smoke by the million tons

The Clean Air campaign has secured many of its objectives but the late afternoon spectacle of a suburban area getting its kitchen boilers going is still often reminiscent of the sort of dockside boiler-firing that legal steps have effectively removed.

And, indeed, the *Clean Air Year Book, 1960*, states that over a million tons of smoke a year are emitted by domestic fires. Industry is responsible for half-a-million and the railways for 100,000.

The domestic fires are not so guilty in terms of content. Their chimneys only puff out 100,000 of the 900,000 tons of grit and dust added to the atmosphere each year. The biggest figure of all is the 5,500,000 tons of sulphur dioxide from all solid-fuel and fuel-oil sources, almost a million of which comes from the domestic fire.

That we are in the middle of rapid improvement is clear from the number of local authorities, 67, who have Clean Air Orders confirmed but not yet in operation, compared with the 68 whose Smoke Control Areas are now functioning. The area confirmed, but not yet operating is 16,401 acres, that already existing, 14,020.

The largest smoke controlled area is that of Hayes and Harlington, Middlesex, with 2,280 acres, whose nearest rival is Bradford with 1,481 acres. Perhaps the people of Hayes and Harlington, wracked by the uproar of London Airport, decided that here was one inconvenience they could remove.

The annual report of the National Society for Clean Air, who publish the Year Book, is seriously concerned at what it calls the efforts being made to restore the deservedly waning popularity of the raw coal open fire. The society is on good ground when it says that the path of opposition to change and reform invariably ends in failure and creates added difficulties to those who choose obstruction rather than adaptation.

In this case, it is not possible to see how partial implementation of the Clean Air Act can benefit any but the most narrow sectional interest. For industry, working in cleaner brighter conditions with less cleaning and illness to pay for; for the housewife, with less drudgery around the house; and for the private individual able to see across the town for the first time in his life; there is nothing but gain.

There will be no medals for rearguard actions here.

Uproar, Decibels and Chipping Castings

Whether it is merely tightening up a loose panel or going all the way to fitting a resilient lining to tumbler cylinders, noise reduction is not a subject that is ever far away.

Too high a noise level in the works is not only unpleasant, nor simply another accident hazard, it plays a definite part in reducing efficiency. One good example is the case of the machine whose warning signals are given audibly.

A background noise that makes this at all difficult for the operator is going to result in frequent checking for what should be capable of drawing attention to itself and possibly in interruption of the smooth flow to watch some alternative indicator. If under these neglected conditions the operative decides to neglect the signal there is risk of serious damage to the equipment.

The background noise to life outside the factory may be rising, though perhaps not as fast as indignation on the subject. Industrially this should be a time when noise is on the decline.

Noise in Factories, the sixth Factory Building Study of the Department of Scientific and Industrial Research (HMSO, 3*s* 6*d*) gives several indications of the way in which equipment more efficiently used is less noisy in itself. Equally, in the exhaust of pneumatic tools it may not make the tool itself more efficient to reduce turbulence, but it will reduce the noise level and the cost of protecting against its effects.

Between sound insulating a whole factory to protect neighbours and building an internal structure around a motor generator set, the gap is considerable. And in the event of the former there is still the problem of looking after the people and the processes boxed in with the noise.

and a Cheap and Abundant Fuel

Fuel is still a large item for most industrial as well as domestic establishments. The tendency is always to use the cheapest fuel and when this happens to be both convenient and clean as well it sounds almost too good to be true.

It is the pride of the electrical supply industry that the cost to the consumer has only risen 20 per cent during the last ten years, whereas coal has risen 75 per cent and gas nearly as much. These were figures quoted by Mr. H. G. Nelson in his paper on electricity supply presented to the recent Electrical Power Convention. Not least among the factors is the point that installation costs of new generating plant are almost exactly the same per kilowatt as they were twelve years ago, and even show a downward rather than an upward trend as the size of sets increases. The greater efficiency of the new larger sets should also help in keeping the price down.

Given a cheap clean fuel with a reliable supply system, industry can make great strides. Processes that demand a large proportion of fuel become more feasible, and heating and living conditions generally show improvement. Lighting can be more generous if it is not a constant worry by expense. A side effect is less fatigue and eye strain.

Eradicate Wood Rot and Pests with Mayonnaise

Thoughts of how mayonnaise manages to get rid of death watch beetles conjures up exciting visions. Imagine, for instance, that the material worked like weed killer. Attracted by the succulence of the new dish the gluttons would overeat to such an extent that they became jammed in their holes and died of suffocation. In order, perhaps, to avoid the inevitable cries of agony which would follow this process, the makers of the new mayonnaise called Woodtreat have included what is now recognised to be a most effective preservative—pentachlorophenol. Don't be scared by the name (unless you're a woodworm) it is just a killing compound.

Woodtreat, made by the new company of Preservation Developments—an offshoot from Standardised Disinfectants—has been introduced from the USA. The secret lies in adding emulsifying agents to an oil-water mixture containing the killer so that it can be whipped up to a uniform consistency. Soon it will be made in this country, but with a killer concentration of 5 per cent in place of the American's 8·7 per cent. The lower concentration will then be similar to that used in spray and dip preservatives such as the well established Brunophen made by the same company.

On the right there are two illustrations—one with a story, and the other with a moral. The one with a story shows preservation of timbers in a yawl with Woodtreat. Unfortunately, after their little treat in the Chelsea basin, the timber pests won't be in very good trim to enjoy the yacht's trip to the Caribbean. The picture on the left is explained in the caption, and has the moral that if anyone doesn't consider Woodtreat for preserving timbers he needs his head examined—probably for dry rot.

This is what the makers have to say about their product. When Woodtreat is applied to the surface of timber it sustains itself on the surface providing a reservoir from which active ingredients can be absorbed in the timber's own good time. It may be considered therefore as a means of dipping or soaking timber without need to transfer it to a tank of preservative. Tests have shown that application of Woodtreat to the surface of timber gives retentions and penetrations equivalent to those obtained by dipping or by application of many brush or spray treatments. It has the additional advantage of penetrating more evenly and of providing, as a result, a more uniform preservative barrier.

Woodtreat is used therefore for preservation of new timber and is particularly suitable for *in situ* preservation. Its use is also suggested for treating laminated beams and other members after fabrication, especially when these are of awkward shapes and sizes.

(Left) This shows penetration of Woodtreat and a typical spray preservative into redwood with a moisture content of 10 per cent. Blocks were 6 × 6 × 2½ in. Both preservatives were dyed green.

From top to bottom:
1 Petroleum distillate after 10 minute dip
2 Woodtreat, 1 lb per cu. ft
3 Woodtreat, 2 lb per cu. ft
4 Woodtreat, 2-3 lb per cu. ft
5 Woodtreat, 3-4 lb per cu. ft
Absorption times were 2-5 days.

(Right) Application to yawl timbers.

The mayonnaise is of greatest interest for eradication of dry rot, woodworm and termites from timber already attacked by these pests. It has been used with great success in the States against termites and found superior to the method of drilling holes followed by injection into them of liquid preservative under pressure. Field trials in the United Kingdom show great promise for control of woodworm and dry rot. It gets to the seat of the trouble and gives a deep barrier to prevent subsequent reinfestation. It has the advantage over spraying of not producing a spray mist which requires use of spray masks, nor does it give rise to the fire hazard associated with that method.

Preservation Developments Limited, 23 Sloane Street, London, SW1.

High PV Values with Graphited Bearing Metal

Before turning the page on what looks like a rehash of an old product, just ruminate on what the makers claim for a new material called Deva. "It is a product of powder metallurgy but in contrast with other well known so-called self-lubricating sintered bearing materials it is non-porous and does not rely on impregnated oil or grease in the porous metal for its self-lubricating property." A natural reaction would be "it contains graphite and doesn't need lubricating—so what? Perhaps it's a little exaggerated, though, to say that it is non-porous." That the density does in fact approach 100 per cent theoretical is vouched for by the strength which is in the range 4 to 7½ tons per sq. in (tensile), this being good for a sintered compact which contains a fine dispersion of graphite in quantities within the 5 to 20 per cent range.

The range of PV factors for which Deva metal is applicable is difficult to specify, say the makers, Universal Metallic Packing Company. However, it has been successfully used in completely dry applications at PV factors up to and above 100 × 10^3 lb per sq. in-ft per min, while PV factors up to 2,800 × 10^3 have been successfully accommodated with varying degrees of lubrication.

Frictional coefficients when absolutely dry are 0·18 to 0·25. This is reduced to 0·08 with good water lubrication and down to 0·05 with partial liquid (presumably oil) lubrication. This lubricating action is retained at high temperatures—bearings having withstood 600°C.

From the maker's point of view, all this would be an oversimplification—for the material called Deva is really one of 14 metals or alloys which can each have a different graphite content. So it's best to put your cards on the table and tell the makers just what the bearings will be used for if you want to really get the best from Deva. The table indicates just how some variations in basic composition will affect the properties.

High strength in compression means they should act well when press or shrink fitted into a housing. Brazing or soldering is not performed easily because of the graphited surface but it can be done after special surface preparation.

Machining characteristics are similar to bronze: carbide-tipped tools honed smooth and dead sharp will give a clean cut without burnishing.

Universal Metallic Packing Company Limited, Leeds Road, Bradford 3.

A Few Successful Uses of Deva Metal

In automobile parts—for steering systems, brake rods, clutch rods, carburettors and rods for radiator flaps.

Bearings for feedways in cooling ovens in the glass and china industries.

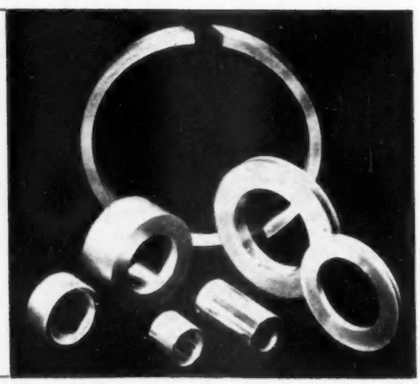
Bearings for sluices and lock gates for use under or above water.

Gliding bearings for heavy work in rolling mills and foundries.

Glide bearings in bogie turntables and for axial assemblies in locomotives and railway wagons.

Piston rings for steam engines, compressors and steam pumps.

Bearings in fittings for atomic reactors.



Choose the Correct Grade with the Maker's Help

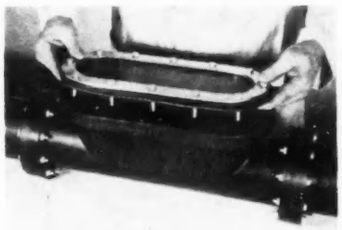
Alloy Symbol	Description	Operating Temperature Range, °C
B 1	Standard bronze	− 50 to 200
BH 1	Special bronze	− 200 to 350
BL 1, 2 and 3	Leaded bronzes	− 50 to 200
C 1, 2 and 3	Standard brasses	− 50 to 200
CH 1	Special brass	− 200 to 350
CL 1	Leaded brass	− 50 to 200
FH 1, 2, 3 and 4	Special irons	Up to 600

Coefficient of Expansion, per °C	
Copper base alloys	16·2 to 18·0 × 10^{-6}
Iron base alloys	10·8 to 12·6 × 10^{-6}
Higher lead containing alloys	19·8 × 10^{-6}

Access Chamber for Polyethylene Drains

Polyethylene plumbing systems are in increasingly widespread use in laboratories, chemical works and atomic energy stations for disposal of effluents, particularly high corrosive and indeed radioactive material, instead of lead and stoneware plumbing. Chemical Pipe and Vessel Company, who produced and installed the first polyethylene plumbing in the world in 1948 at Rothamsted, are now engaged on a number of these polyethylene drainage contracts, including the new power stations at Berkeley and Bradwell-on-Sea, and the UKAEA plutonium extraction plant at Salwick.

One of the more recently developed moulded fittings in polyethylene for this type of work is the access chamber shown, which is inserted in drain-



age lines for inspection and cleaning. A polyethylene lid with chemically resistant rubber gasket is fitted with non-corrodable bolts and, if necessary to resist pressure, a stainless steel backing ring also.

Chemical Pipe and Vessel Company Limited, 1 Hayes Lane, Kenley, Surrey.

Salt Mines in Cheshire Boring Work

New large deposits of salt have been discovered in the Cheshire Basin as the result of deep boring by the Geological Survey of Great Britain. The boring operations—including one borehole to a depth of slightly more than 5,500 ft—have revealed reserves of salt estimated at about 400,000 million tons.

For some years the Geological Survey's North-West England field unit has been making a 6 in to the mile geological survey of the Cheshire Basin and its extension into North Shropshire—an area of some 800 sq. miles, including the well-known Cheshire salt field.

To gain further geological knowledge of this area, which has extensive superficial deposits of sands, gravels and boulder clay overlying the solid rocks, exploratory boreholes were essential. In 1953-54, ten boreholes were drilled in the Stockport area and in 1958-59, fifteen were drilled in the Cheshire-Nantwich areas. Depths of the boreholes varied from 300 to 1,000 ft; they helped considerably to prove the structure and extent of the salt field.

To knit these results together and to prove the complete succession of these salt-bearing rocks, a deeper borehole was drilled farther to the south. Hitherto, the salt industry of Cheshire has been thought to draw its brine from one group of saliferous beds about 600 to 800 ft thick, but it is now clear that there are two salt bearing groups; the lower group is that exploited in the neighbourhood of Northwick and Winsford while the brine pumped around Sandbach and Middlewich appears to belong to the upper group.

The lower salt group extends beneath about 400 sq. miles and the upper salt group beneath about 170 sq. miles of the Cheshire Basin with, in each case, a further undefined extension southwards. The reserves of salt which would reasonably have been computed from previous information have been at least doubled; a provisional estimate of reserves now amounts to about 400,000 million tons, of which over 60 per cent is in the lower group.

Production of salt in the United Kingdom in 1957 was about 5 million tons. The chemical industry is a major user of salt in the form of brine for the production of soda-ash.

Hypalon Based Paint

A liquid coating having elastomeric properties is announced. This product, Texseal, is a development of the chemical products division of the Dunlop Rubber Company. It is based on Du Pont's Hypalon rubber.

The important properties offered by Texseal result from the outstanding properties of Hypalon (chlorosulphonated polyethylene), which has been formulated with various other ingredients. Principal among these properties are chemical and ozone resistance. It also has good flame resistance and is suitable for continuous service at temperatures up to 250° C. Because of the excellent oxidation resistance of the base polymer, pigmented Texseal exhibits good colour retention.

Texseal can be satisfactorily applied to a variety of substrates such as concrete, steel, fibreboard, wood and rubber with good adhesion between the coating and base material. Application is similar to that of other paints in that it can be brushed, sprayed or applied by dip and spread coating.

Normally, coating thicknesses are about 2 mils (0·002 in) with a coverage of 150 to 250 sq. ft per gallon. When sprayed, the conventional type of lacquer or enamel spray equipment is used. For correct spraying characteristics the solids content of Texseal is lower than that customarily used for brushing. After application the film of paint dries quickly and simultaneously commences to cure. This can be accomplished at either room temperature which takes a few days, or at elevated temperature, about 250° F, which occupies a few minutes.

Applications of Texseal are numerous. It can be sprayed on to foam or fibre board to give a brightly coloured, decorative finish. It can also be applied to wood as a trim and shutter paint or for boat decks. It has been successfully applied over natural and synthetic rubbers, though care must be taken to ensure that the substrates contain no migratory plasticiser or staining material else the Texseal will become discoloured.

Obtainable through Vicsteels Limited, 16 Northumberland Avenue, London, WC2.

Cure-All Claim for Mercury in Condenser Tubes

Although mercury was one of the apothecary's rather ruinous cure-alls for congested tubes, technical men have seldom taken seriously any suggestion that the same metal can improve condenser tube alloys. There is far too much evidence, you will hear around the trade, that mercury can quickly destroy condenser tubes; there is the example where a mercurial grease was used on a condenser bank with ruinous results. Accidental additions form local concentrations and cause stress corrosion. Hence it was with merriment and mirth that the claims were read for alloy No. 77 for which patents were granted in 1959 to Bridgeport Brass Company in the USA.

As in many examples where we didn't think of it first, this merriment has gone rather sour now that continued evidence is made available that this alloy is living up to its claims. It is not complex—its composition is 0·05 Hg-30 Zn-brass with low lead and iron.

Thus BNFMRA are now performing corrosion tests on such alloys and other firms are known to be showing more than casual interest.

Numerous field tests have shown that the addition of mercury to alloy 77 has substantially increased resistance of this copper based alloy to biofouling. For example, the surface of alloy 77 remains clean when exposed to environments where other copper-based alloys became biofouled. Any residual slime or algae clinging to the surface adheres very poorly and can be easily removed. In some cases, rinsing with water is sufficient.

How New Alloy Compares with Other Condenser Tube Alloys

	Alloy 77	Arsenical Admiralty Brass	30 Ni-Copper
Tensile strength, lb per sq. in			
Hard	78,000	—	80,000
Soft	47,000	45,000	55,000
Yield strength, lb per sq in			
Hard	64,000	—	70,000
Soft	15,000	15,000	22,000
Elongation on 2 in, per cent			
Hard	8	10	5
Soft	65	65	45
Thermal conductivity, at 68° F, Btu per ft-hr.-deg. F	70	64	17

Then there are other claims which are even more difficult to stomach: "tests also show that this new Bridgeport alloy resists dezincification and has an increased resistance to impingement corrosion over that of other copper-zinc alloys."

Excellent antibiofouling characteristics of alloy 77 make it suitable as a condenser tube alloy in the surface condensers of steam electric stations where maintenance of heat transfer and overall efficiency is important. Results of field tests where alloy 77 condenser tubes were installed in surface condensers have shown that this alloy gives satisfactory service handling fresh, brackish or saline waters at velocities up to 7½ ft per sec. These service installations also demonstrate that alloy 77 possesses good to excellent resistance to condensing steam.

A number of these tubes have been satisfactorily tested in petroleum refinery services. In each of these applications, they gave results equal to or better than inhibited admiralty brass handling refinery process streams.

Secret to the Bridgeport achievement seems to lie in the method of getting mercury into solution and avoiding uneven concentrations. Apparently it is added as an amalgam.

Bridgeport Brass Company, Bridgeport 2, Connecticut, USA.

SERVICE EXPERIENCES WITH ALLOY 77

Florida.—30,000 sq. ft of surface condenser tubes in plant near Tampa, Florida: after 26 months there was no evidence of impingement corrosion at water velocity of 6·4 ft per sec; tubes still to original 18 BWG. No corrosion at inlet end even after 4 years. Sea water in this instance was polluted.

Houston, Texas.—Cooling water at installation on a bayou caused rapid biofouling on copper base alloy steam condenser tubes. Alloy 77 tubes are still in service handling cooling water at 6 ft per sec.

Beaumont, Texas.—Following successful tests with alloy 77 in a surface condenser serving a 30,000 kW utility a further condenser for a unit twice the size was retubed with the alloy. The water from the Neches river caused less scale build-up at a velocity of 7 ft per sec than on other tubes.

New Orleans, Louisiana.—Brackish cooling water on the industrial canal site of a power company has left the alloy 77 tubes in "excellent" condition after 3 years.

Reinforced Plastic Moulding

J. W. Roberts Limited point out that we omitted to say that it is they who make Feroglas reinforced plastic products such as the water container for AEI-Hotpoint mentioned on p. 2 of the July 1 issue of ENGINEERING. Although the name Feroglas is well known, we are happy to introduce the makers to those who don't know it.

Plain Words

By Capricorn

WHAT a way to run society! Juvenile delinquency is increasing in countries with the highest standards of living and the most extensive systems of universal education. In the United States, 12 per cent of children from the ages of 10 to 17 appear in juvenile courts.

During the past two weeks, delegates to the United Nations Congress on the Prevention of Crime and Treatment of Offenders have been discussing this world wide problem at their meetings in London. It is a very complex problem. I believe the engineering industries could help to solve it.

If you are blessed with a reasonable brain, the full-employment welfare state is kind to you. It provides free education to a high level and then more or less guarantees you a comfortable job. But if you are born with a low-power brain, God help you. The socialist creed of equal opportunities for all will mock you from the first day as a youngster that you wake up to the fact that the world is not organised for the likes of you. Your schoolmaster makes it quite clear that the world is waiting for the little prigs who come out top every term. But the world is not waiting for you. Far from it!

Long before leaving school, you will have realised that you stand no chance of owning a car and living in a grand way on the sort of pay the world is going to give you when you leave school. But everyone is hungering and thirsting after a high standard of living. The Prime Minister says it's important. It's kind of morally good to have a motor-car. And it gets you girls, too.

So you "borrow" a motor-car. You only keep it for two days. You don't particularly want to take it from the chap who owns it, but you want one for your own use—while the prigs are still swotting away in the sixth form! Next time you must have one, you borrow another.

In the London metropolitan area, more than 20,000 motor vehicles are stolen or "borrowed" every year. Of this total, 63 per cent are taken by the age group 8 to 20, and 31 per cent by the 21 to 30 group.

The appalling inflexibility of our educational system, which aggravates this sickness of society, is the result of our scientifically based industries demanding ever higher educational standards. Where we have gone wrong is to try and put everyone through this educational system. We would do better to take those who are obviously not cut out for an academic approach—take them at the age of 12 or thereabouts—and give them some satisfying, rewarding work in industry.

No room for philanthropists in the welfare state? No need for a new Charles Dickens? Here is a menacing evil staring us in the face. The engineering industries could help to abolish it by creating simple opportunities at an early age for those who are just as anxious as the rest of us to enjoy a high standard of living.

Letters to the Editor

Plastics Bearings for Greaseless Cars

SIR, As a major supplier of steering linkage and suspension equipment to leading vehicle manufacturers in this country and overseas we were interested in your article on "Plastics Bearings for Greaseless Cars" (ENGNG., 22 July '60, p. 132).

We would agree with the comment attributed in your article to a paper by Mr. J. W. Lane and Mr. C. F. Foell, published by the National Lubricating Grease Institute, that effective sealing is essential for a plastic bearing. There has been a problem in obtaining an adequate seal at an acceptable cost which will work under the severe mechanical requirements and in the highly abrasive conditions existing near the road wheels. This factor has retarded the adoption of prelubricated plastic bearings for the chassis.

However, for the past two years in conditions less severe than those existing at the wheel outer steering joints, plastic bearings have been used in the steering linkage of a popular small car. No provision is made for greasing and no adverse service reports have been received from over 200,000 units now in the field. Following development over a number of years on the seal and other components it is now possible to incorporate plastic bearings so that the life and performance of the complete bearing unit is better defined without any periodical attention being necessary.

We wonder whether the description "greaseless" is correct; most plastic bearings are initially lubricated on assembly, the seal then serving to keep contaminants out and lubricant in. The lubricant may also serve the added purpose of retarding corrosion of the steel shaft.

The plastic bearing materials possess properties which are unfamiliar and which originally appeared to limit their use to low unit loadings due to the deformation which can take place. Following changes in the design approach, advantage can now be taken of this deformation at the low surface speeds associated with chassis components.

Clearance is necessary with rigid bearing materials and may result in inadequate bearing area, wedging and hammer. If the structure surrounding a plastic bearing material is arranged to take care of the measurable deformations which exist under load, it is possible to produce a unit without inbuilt clearance as the normal type of seizure does not take place. The plastic material deforms within the surrounding structure under the load and the area available for load support rises. However, the design of the assembly must take account of any slight swelling resulting from water absorption.

Certain plastic materials can operate at unit loads far above those which a rigid bearing material will accommodate, as they appear to have the feature of retaining some of the lubricant at the bearing-to-journal interface. Rig tests have shown that both the plastic bearing and the journal surface, after many millions of cycles, have highly polished surfaces, with little or no measurable wear; while data obtained from such running tests indicate that fatigue life is superior to that obtained from comparable rigid assemblies.

For certain ball joints the use of plastic bearings enables a reduction in turning torque to be achieved, but modifications may be necessary to other features of the vehicle to ensure that undesirable side effects do not appear as a result of loss of damping. In addition, the use of plastic bearings in the steering and suspension system provide a further means of insulation between the driver and the road.

The soft plastic material can accommodate some abrasive particles which could cause distress in a poorly-lubricated rigid bearing. The dirt embeds in the plastic, due to the unit pressure and temperature generated by rubbing, and then usually sinks below the interface surface and does little further damage. In a rigid bearing, the abrasive matter continues to cause wear until it is ground away.

In one vehicle application of a ball joint in which unit loads can vary from 8,000 lb per sq. in at an equivalent surface speed of 3 ft per min to 4,000 lb per sq. in at 16 ft per min, greased steel on steel, steel on bronze and other similar rigid bearing materials failed on prototype test. A bearing made of a thermoplastic which had been treated to improve its load-carrying properties and which is only greased on initial assembly has proved to have an adequate service life in production.

Engineering information is still lacking about plastic bearings. The adoption of plastics as a bearing surface in an economical way has required a different approach from that adopted with rigid bearings. Information, such as is contained in the reports mentioned in the article, is extremely valuable and it is possible to foresee a rapid increase in the use of plastic bearings. Designs which are not possible at the moment, due to breakdown of conventional bearing materials, will become available as the plastic bearing materials open up a new field of operation and, in consequence, will find an increasing number of outlets.

Yours faithfully,
C. L. DONNELLAN,
Technical Director.
Engineering Productions (Clevedon) Limited,
Clevedon, Somerset.
9 August, 1960.

Concrete Strengths

SIR, In his recent letter (ENGNG., 1 July '60, p. 4) Dr. J. M. Plowman asks if I will plot my results published for concrete cubes cured at 35° C (27 May '60, p. 713) on a log maturity base, with any 28 day results I may have.

When tracking strength development in detail, there is, unfortunately, a great temptation to use every available cube, and I have normal 7 or 28 day results for only two or three of the curves published with my letter. I have given these results in the accompanying table, together with further results from similar tests. The accelerated strengths are generally based on the average path followed by a large number of cubes, and

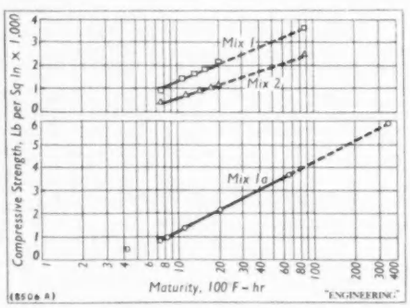


Fig. 1.

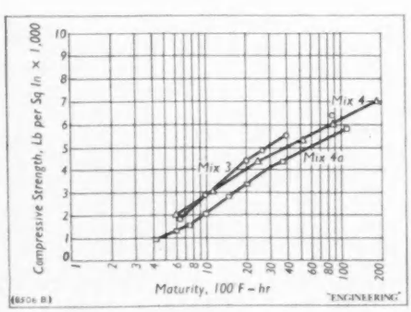


Fig. 2.

all the results are plotted on a log maturity base in the accompanying Figs. 1 and 2.

Fig. 1 relates to concretes with a total water/cement ratio of 0·55 and 0·65, and it will be seen that the points given by the normally cured cubes are almost in line with those given by cubes cured at 35° C, but this may be a coincidence. Fig. 2 relates to concretes with a total water/cement ratio of 0·45. In none of the graphs does the first point of discontinuity occur after a maturity of about 750° F-hr has been reached, though this would not necessarily be true for higher strength concretes.

At the time of writing my earlier letter, I had not seen Mr. R. Narayanan's article entitled "Predictable Strength of Young Concrete" (29 April '60, p. 580), but I have since been very interested to note the similarity between the

TABLE

Mix	Brand of cement	Total water/cement ratio	Hours curing	Curing temperature, °F	Maturity °F-hr (datum 11° F)	Strength lb per sq. in
1	B	0·55	9	95	756	950*
			13	,,	1,092	1,450
			16	,,	1,344	1,650
			19	,,	1,596	1,850
			24	,,	2,016	2,180
			168	63 approx.	8,736	3,635
1a	B	0·55	5	95	420	480
			8½	,,	714	850
			10	,,	840	1,000
			14	,,	1,176	1,430
			24	,,	2,016	2,150
			77½	,,	6,510	3,633
			672	63 approx.	34,944	5,900*
2	B	0·65	9	95	756	430*
			14	,,	1,176	750
			17½	,,	1,470	950
			21	,,	1,764	1,080
			24	,,	2,016	1,180
			168	63 approx.	8,736	2,448
3	A	0·45	7½	95	630	1,800
			12	,,	1,008	2,850
			24	,,	2,016	4,400
			32	,,	2,988	4,850
			48	,,	4,032	5,500
			168	63 approx.	8,736	6,385
4	B	0·45	5½	122	610	2,000
			10½	,,	1,165	3,060
			22	,,	2,442	4,372
			47½	,,	5,272	5,300
			79	,,	8,769	6,000
			168	,,	18,648	7,000
4a†	B	0·45		95	420	900
				,,	600	1,270
				,,	750	1,550
				,,	1,000	2,050
				,,	1,500	2,800
				,,	2,000	3,350
				,,	3,750	4,400
				,,	11,110	5,800

* Estimated result based on another almost identical batch.
† Average results of two batches almost identical with Mix 4.

changes in slope which he has obtained with richer mixes at normal curing temperatures, and the changes I have found with concretes of 0·45 total water/cement ratio at 35° C. In both cases, the changes occur at a maturity of approximately 2,500° F-hr. A limited number of tests had also suggested to me that a marked change in the pattern of strength development occurs at about 70° C, and Mr. Narayanan has shown this very clearly.

When attempting to predict normal 7 and 28 day strengths from accelerated tests, I think it should be realised that the detailed pattern of strength development of normally cured concrete is not necessarily, if ever, a smooth curve. Work I am engaged upon at present suggests that steps, similar to the ones which occur when curing at 35° C, but lasting for one or more days rather than hours, may be present in the patterns of concretes cured normally. If this is so, the average strength of even a large number of cubes tested at, say 7 days, would not necessarily lie on a smooth curve drawn through points given by 6 to 9 day tests.

Yours faithfully,
M. S. THOMPSON.

11 Old Fold View,
Barnet,
Herts.
8 August, 1960.

Bearing Wear

SIR, I am sorry my recent article "Bearing Wear in Corrosive Atmospheres" (ENGNG., 17 June '60, p. 841) should have upset Mr. A. C. Wren (5 Aug. '60, p. 172).

I am sure you will permit me to say the title to which he takes exception was decided by yourself. I have no quarrel with your decision, but if I had I would remain silent for I consider that an Editor has rights in editorial matters and should not be questioned by laymen.

Mr. Wren is, of course, right when he says that the life/load relationship for lubricated bearings is incorrectly quoted. I know the correct form. However, for allowing this error to get through proof reading I apologise to you, Sir, and to your readers.

I had not room to give all the results which lead us to think that an exponential rather than a cubic relationship holds for unlubricated ball bearings under the conditions I quoted in the original article. The results have passed tests of statistical significance. It may be possible for us to publish our work on this subject more fully later. Incidentally, the wear of bearings of many kinds is much more reproducible when they are unlubricated than when they are lubricated.

Yours faithfully,
H. H. HEATH.

The English Electric Company Limited,
Cambridge Road,
Whetstone, near Leicester.
8 August, 1960.

Airships for Feeder Services

SIR, There is no doubt but that airships have much to commend them for use over cities, between the airports and city centres. So Mr B. G. Bodroghy's interesting article, "Airships for Noiseless Feeder Service" (ENGNG., 22 July '60, p. 124), was quite timely. A good many problems are involved, but this is true whatever the solution.

So far as obtaining a false lift by superheating the gas is concerned, I think the maximum so far achieved is about 5°. So there is a long way to go before the suggested 30° superheat is likely. Perhaps it is better to take things as they are and ignore, for example, the possibility of boundary layer control which, if achieved, may mean an increase in speed of about 20 per cent, or a considerable increase in useful lift. Experiments on these lines are continuing in the United States, and there is quite a chance of success. Unfortunately, these things cost money and little is ever available for airship research.

I would rather suggest the possibility of improving control in the vertical plane, by the revival of swivelling propellers, as these would give airships much of the advantages of helicopters, by making it possible to take-off and land vertically when heavier than air.

To give an example. The Goodyear L class can be flown at about 700 lb heavy, if there is sufficient room for an aerpolane take-off. These ships have a volume of 123,000 cu. ft and their twin motors totalling 290 h.p. give these ships a maximum speed of about 65 m.p.h.

The old British airship Delta of 1912 had a volume of 173,000 cu. ft, and her 200 h.p. gave her a speed of 44 m.p.h. But her pair of swivelling propellers made it possible for her to take-off and land vertically while up to 750 lb heavy and, on one occasion at least, she landed 250 lb light without valving.

It must be admitted that these propellers, which could be turned to drive the ship ahead and astern, and up and down, gave a certain amount of trouble, but surely modern knowledge, and lighter and stronger materials, should achieve better results than were possible in 1912!

Such an airship would need a landing space of not more than twice the ship's length and so it might, perhaps, be possible to find sheltered landing places in the parks of a city. Provided that the actual sites for taking-off and landing were well sheltered from the wind, such a ship, with a cruising speed of say 70 m.p.h., could be employed on most days of the week and, although wind would slow her down, she would fly in a direct line from point to point, and would never be held up by traffic jams. Fog, too, would not matter very much and she could fly when other aircraft would be grounded.

The mooring mast and mechanical handling, both of British origin, and swivelling propellers, also British, would reduce the handling parties to about a dozen. But it's impossible to suggest the size and other details of such an airship, as everything depends on the number of passengers to be carried.

One can only say that these passengers would enjoy such trips, for they would travel in comfort and quietly and enjoy a bird's-eye view from a height of perhaps 500 ft.

If the engine of a helicopter should stop down it must come, and at once. In the case of the airship a mechanic could usually put things right, while the pilot free-balloons his ship. At the worst, a free-balloon landing could be made when clear of the city. When a heavier-than-air machine breaks down, it comes down at once; the airship on the other hand, by dropping ballast, could be made to rise.

As for noise, the airship's engines could be silenced, and the noise of air traffic at the airport, and ground transport in a city, would certainly drown any noise made by the airship. I have flown many times over large towns in airships in recent years and very few people hear the ship and look up.

So I think that airships certainly deserve to be considered.

Yours truly,
VENTRY.

Lindsay Hall,
Lindsay Road,
Bournemouth.
10 August, 1960.

The Tarmac Group

SIR, I feel I must point out some errors in the paragraph headed "Administrative Offices and a Welsh Bridge" (ENGNG., 5 Aug. '60, p. 193).

The TG Construction Company Limited is a member of the Tarmac Group—not TG Tarmac Group—and the TG Civil Engineering Limited should read Tarmac Civil Engineering Limited.

Tarmac Civil Engineering Limited and TG Construction Company Limited are, in fact, both members of the Tarmac Group of Companies.

Yours faithfully,
AUBREY ST. CLAIR-FORD.

Tarmac Civil Engineering Limited,
50 Park Street, London, W1.
9 August, 1960.

Events in Advance

When its Really Hot

WHEN first introduced, the Nimonic series of heat-resisting alloys produced by Henry Wiggin and Company Limited, were used exclusively in aeronautics but, in recent years, as other industries have taken more and more to working to higher temperatures, the use of these and other high-temperature alloys has been expanding steadily.

In the past, the company have organised no fewer than 15 exhibitions dealing with products of this kind, in the main industrial centres of Britain. They have now arranged a new exhibition which will concentrate exclusively on Wiggin high-temperature alloys. This display will include the Nimonic series, the Nimocast series, Inconel, Incoloy and Incoloy Ds, and will demonstrate the properties and applications of these alloys by various means, including the use of diagrams and a comprehensive range of

components and sub-assemblies in which the firm's materials are employed.

The exhibition, which will be based on the theme " When It's Really Hot," will be on show at the Grand Hotel, Sheffield, from 20 to 22 September, and at More's Hotel, Glasgow, from 27 to 29 September next. During the course of the exhibition, there will be a number of lectures on high-temperature problems, delivered by members of the firm's technical service, as well as a series of film displays.

Additional information may be obtained rom the firm's headquarters, Wiggin Street, Birmingham 16; or from their London office, Thames House, Millbank, London, SW1. Telephone: VICtoria 3888.

British-Swedish Computers: Conference in Stockholm

In the belief that, even now, the average businessman of today is not fully aware of the outstanding developments that have been taking place in connection with computers and data-processing, the British-Swedish Chamber of Commerce in Sweden have arranged to hold a one-day conference on this theme on 16 September next. The Chamber feel that it is of growing importance that businessmen should have a clearer understanding of how these matters are likely to have a direct bearing on their own offices and factories in the immediate future.

Notable contributions and developments have been made to international computer techniques by both British and Swedish industry recently and it is likely, therefore, that Anglo-Swedish trade in this connection will increase rapidly during the next few years.

At the forthcoming conference it is intended that leading authorities on the subject shall show how the main developments to date have taken place, discuss probable applications in the immediate future, and indicate the possible trends in the years further ahead. An attempt will be made to evaluate the size of the markets and their possibilities. Above all, it will be the accepted aim of the meeting to inform the delegates regarding the extent to which equipment for electronic data-processing will impinge upon the general pattern of life.

The principal British speaker will be Mr. Sebastian Z. de Ferranti, a director of Ferranti Limited, Hollinwood, Lancashire, a firm who already have several installations in Sweden to their credit. The principal Swedish speaker will be Mr. Bengt Andrén, head of the organisation planning department of Allmänna Svenska Elektriska AB (ASEA), Västerås, Sweden.

Applications to attend and requests for additional particulars should be sent to the secretary, British-Swedish Chamber of Commerce in Sweden, 5B Hovslagargatan, Stockholm C, Sweden.

United Nations to Discuss New Sources of Energy

Three conferences of an international character have already been organised, under the auspices of the United Nations, for the study of various aspects of the world's energy resources.

A preliminary review of the research being undertaken in respect of some new sources of energy was made by the United Nations Scientific Conference on the Conservation and Utilisation of Resources (UNSCUR) in 1949. The United Nations Educational, Scientific and Cultural Organisation held a symposium in New Delhi in 1954 on the scientific aspects of wind and solar energy, and the International Association for Applied Solar Energy organised an international conference on solar energy at Phoenix, Arizona, USA, in 1955.

It has now been decided to hold a United Nations Conference on New Sources of Energy at some centre in Europe from 17 to 27 August, 1961. The meeting will discuss practical problems and experience concerning the utilisation of the three sources of power: solar energy, wind power and geothermic energy; especially in relation to the difficulties confronting the less-developed countries. It is noteworthy that no conference of an international character has so far ever been held on geothermic energy.

The agenda of the new conference is being drawn up so as to focus attention on applications rather than upon the discussion of scientific principles and basic research. It is considered that the three sources of energy, solar, wind and geothermic, are of special interest, particularly in areas which are facing fuel scarcities or high-energy costs, or both. The three sources differ in regard to the methods by which energy from them can be derived and the uses to which such energy can be put. In short, a fuller understanding is needed of the potentialities and limitations of each source, as well is the possibilities for their combined use with each other and with other sources of energy.

Details regarding the organisation of the conference and the conditions under which participation in the function may take place are due to be published shortly in a special pamphlet. Copies will be obtainable at United Nations information centres in various countries throughout the world or from the Press Services, Office of Public Information, United Nations, New York, USA.

Exhibitions and Conferences

Graz International Autumn Fair.—Sat., 1 Oct., to Sun., 9 Oct., in Graz, Austria. Apply, in the United Kingdom, to the Office of the Austrian Foreign Trade Representative, 1 Hyde Park Gate, London, SW7. Tel. KNIghtsbridge 6938.

Metz International Trade Fair.—Sat., 1 Oct., to Sun., 16 Oct., in Metz. Agents in the United Kingdom: Auger and Turner Group Ltd., 37-38 Margaret Street, Cavendish Square, London, W1. Tel. HYDe Park 7282.

Nigeria Exhibition.—Sat., 1 Oct. to Sat., 22 Oct., in Lagos. Organised by the Federal Ministry of Commerce and Industry, Broad Street, Lagos, Nigeria.

Zaragoza National Fair, 20th.—Sun., 2 Oct., to Thurs., 20 Oct., at Zaragoza. Apply to the Camara Official de Comercio e Industria, 18 Jaime I, Zaragoza, Spain.

Instrument Symposium, Tenth Annual.—Mon., 3 Oct., to Thurs., 6 Oct. Also the **Research Equipment Exhibit.**—Tues., 4 Oct., to Fri., 7 Oct. Both events to be held at the National Institutes of Health, Bethesda 14, Maryland, USA, from which address further details may be obtained.

Textile Exposion, 21st Southern.—Mon., 3 Oct., to Fri., 7 Oct., at the Textile Hall, Greenville, South Carolina, USA. Organised by the Southern Textile Exposition, 322 West Washington Street, Greenville, South Carolina, USA.

Motor and Motor-Cycle Show, 47th International.—Thurs., 6 Oct., to Sun., 16 Oct., in Paris. In the United Kingdom, application should be made to Mr. R. C. Liebman, 178 Fleet Street, London, EC4. Tel. CITy 5889.

Machine Tool Exhibition, Italian.—Fri., 7 Oct., to Sun., 16 Oct., at Milan. Organised by the Uniope Construttori Italiani Macchine Utensili, 22 Via Palestro, Milan, Italy.

Hardware-Houseware Fair, Fifth Annual.—Sun., 9 Oct., to Fri., 14 Oct., at the Barbizon Plaza Hotel, New York. Apply to the general manager, the Annual Hardware-Houseware Fair of the United States Inc., Barbizon Plaza Hotel, 106 Central Park South, New York 19, USA.

Electronics Conference and Exhibition, 16th Annual National.—Mon., 10 Oct., to Wed., 12 Oct., at the Hotel Sherman, Chicago. Conference offices: 228 North La Salle Street, Chicago 1, Illinois, USA.

Hardware Show, National.—Mon., 10 Oct., to Fri., 14 Oct., at the Coliseum, New York. Organised by the Charles Snitow Organization, 331 Madison Avenue, New York 17, USA.

Office Equipment Exhibition, Eleventh.—Fri., 14 Oct., to Sun., 23 Oct., in Paris. Organised by the Salon International de l'Equipement de Bureau, 6 Place de Valois, Paris.

Packaging Exhibition, International.—Fri., 14 Oct., to Sun., 23 Oct., in Paris. Apply to the Salon de l'Emballage, 40 Rue du Colisée, Paris 8e.

German Soap Fair.—Sat., 15 Oct., to Tues., 18 Oct., in Berlin. Includes chemicals and chemical plant. In the United Kingdom, applications should be made to Mr. Neven du Mont, 123 Pall Mall, London, SW1. Tel. WHItehall 8211.

Tunis International Trade Fair.—Sun., 16 Oct., to Mon., 31 Oct., in Tunis. Apply to the Foire Internationale de Tunis, Palais Consulaire, Avenue Rouston, Tunis, Tunisia.

Metal Exposition and Congress, 42nd National.—Mon., 17 Oct., to Fri., 21 Oct., at the Trade and Convention Center, Philadelphi, Pa., USA. Organised by the American Society for Metals, Metals Park, Novelty, Ohio, USA.

Shoe Show, National.—Sun., 23 Oct., to Wed., 26 Oct., at Palmer House, Conrad Hilton, Morrison and Congress Hotels, Chicago. Including machinery exhibits. Organised by the National Shoe Fair, Palmer House, Chicago 90, Illinois, USA.

Montreal International Trade Fair, Fourth.—Tues., 25 Oct., to Sat., 5 Nov., at the Show Mart, Montreal. Organised by the Montreal International Trade Fair Management, 1600 Berri Street, Montreal, Canada.

Household Goods Exhibition (Salon des Arts Ménagers).—Wed., 26 Oct., to Sun., 6 Nov., in Geneva. Offices of the exhibition: 1 Rue du Temple, Geneva, Switzerland.

Saigon International Trade Fair.—Wed., 26 Oct., to Fri., 25 Nov., at Saigon. Apply to the Saigon Chamber of Commerce, Tu-do Street, Saigon, S. Vietnam. In the United Kingdom, applications should be made to the Economic Department, Embassy of Vietnam, 12 Victoria Road, London, W8. Tel. WEStern 3765.

Automation Merchandising Association (National), Convention and Exhibition.—Sat., 29 Oct., to Tues., 1 Nov., at the Exhibition Hall, Miami Beach, Florida. Organised by the National Automatic Merchandising Association, 7 South Dearborn Street, Chicago 3, Illinois, USA.

Dairy Industries Exhibition, 22nd.—Mon., 31 Oct., to Sat., 5 Nov., at the International Amphitheatre, Chicago. Organised by the Dairy Industries Supply Association, Inc., 1145 19th Street NW, Washington 6, DC, USA.

Motor Show, 42nd International.—Thurs., 3 Nov., to Sun., 13 Nov., in Turin. Organised by the Associazione Nazionale fra Industrie Automobilistiche e Affini, 61 Corso Galileo Ferraris, Turin, Italy.

Bottling Exhibition, 13th International.—Sat., 5 Nov., to Mon., 14 Nov., in Paris. Apply to the Bureau Permanent, Salon International du Materiel d'Embouteillage et des Industries Connexes, 28 Rue Louis-le-Grand, Paris, 9e.

Automobile Show, 38th International.—Thurs., 10 Nov., to Sun., 20 Nov., at the Pan Pacific Auditorium, Los Angeles. Apply to Mr. Charles H. Elmendorf, Los Angeles Motor Car Dealers' Association, Suite 300, 8721 Sunset Boulevard, Los Angeles 46, California, USA.

Electronic Research and Engineering Meeting, Northeast.—Sat., 12 Nov., to Sat., 19 Nov., at the Commonwealth Armory, Boston. Apply to the secretary, Northeast Electronic Research and Engineering, 74 Tremont Street, Boston, Mass., USA.

Western Tool Show.—Mon., 14 Nov., to Fri., 18 Nov., at the Sports Arena, Los Angeles, California, USA. Organised by the American Society of Tool Engineers, 10700 Puritan Avenue, Detroit 38, Michigan, USA.

Supervisors in Industry, Residential Course for.—Sat., 3 Dec., to Sat., 10 Dec., at Madingley Hall, near Cambridge. Organised by the Board of Extra-Mural Studies, the University of Cambridge, Stuart House, Cambridge. Tel. Cambridge 56275.

Electrical Engineering, Conference on Non-Destructive Testing in.—Wed., 8 Nov., to Fri., 10 Nov., 1961, at the Institution Building, London, WC2. Organised, in association with the British National Committee on Non-Destructive Testing, by the Measurement and Control Section of the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. Tel. COVent Garden 1871.

Large Electric Systems, International Conference on.—Wed., 16 May, to Sat., 26 May, 1962, at the Fondation Berthelot, 28 Rue Saint Dominique, Paris. Organised by the Conférence Internationale des Grands Réseaux Électriques (CIGRÉ), 112 Boulevard Hausmann, Paris. Apply to the British National Committee, Thorncroft Manor, Dorking Road, Leatherhead, Surrey. Tel. Leatherhead 3433.

Foundry Trades Fair, Second International (GIFA).—Sat., 1 Sept., to Sun., 9 Sept., 1962, in Düsseldorf. As in 1956, when the first fair was held, the German Foundrymen's Association will hold their annual meeting during the fair. Organisers: Nordwestdeutsche Ausstellungs-Gesellschaft M.B.H., 4 Ehrenhof, Düsseldorf, Germany.

Light Magic with Semiconductor Devices

Solar cells convert sunlight directly into electricity. Owing to their extreme lightness and reliability many commercial applications will open up as soon as the costs are sufficiently reduced.

IN THE years up to 1850 mankind consumed one-third of the world's fossil fuel reserves; in the hundred years from 1850 to 1950 he managed to use up half as much again. Sunshine along with nuclear and thermonuclear power remain the last unexploited energy resources, but solar energy is unique in two respects. The fuel is free, and solar cells show promise of economical electricity generation in the smallest quantities at the site of consumption.

Direct conversion of light into electricity was discovered some time ago but the high cost and low efficiency of the original selenium cells seriously limited the scope of application. In 1954 the silicon semi-conductor photovoltaic cell was discovered in the Bell Laboratories. Even in the early stages of development the silicon cell had much better conversion efficiency than its predecessor, the selenium cell, which was operating at 1 per cent or even lower efficiency.

In essence the silicon cell is not very different from a transistor diode using a P-N junction, and in fact the manufacturing steps are identical up to the point of forming the junction. In a solar cell it is essential to make one of the layers sufficiently thin to permit penetration by light to the junction as shown in Fig. 1. To obtain such a thin layer, which may be of the order of 2 microns, one technique is to cut standard wafers of N-type silicon and deposit on this a film of boron from vapour at 1,150° C. Boron then diffuses into the base layer transforming the surface into P-type silicon and forming the P-N junction.

Since 1954 the silicon cell has been rapidly developed on a para-commercial scale in anticipation of space projects, and has been used to power the highly successful TIROS weather observation satellite. International Rectifiers, who made the TIROS installation, are now looking for other applications to widen the commercial base of their operation. Success will depend on ingenuity in finding suitable applications and in reducing the cost of solar electricity.

Cost reductions can be effected through divergent methods. Efforts can be made to improve the efficiency of the cell and thus reduce the quantity of material used and the surface area required. Conversely, by relaxing production standards low efficiency cells could be mass produced at radically reduced cost

The maximum attainable conversion efficiency of solar cells is determined by the relationship of the light spectrum and the response of the cell. In Fig 2 it can be seen that the cells are most sensitive to light in the "heat" end of the visible spectrum, but most of the energy in the sun's rays is contained in the violet end With present materials the lack of correspondence between light spectrum and response limits the theoretical conversion efficiency to about 19 per cent, while the best cells so far produced have only reached 14 per cent.

To exceed the theoretical limit of 19 per cent some material other than silicon must be found which has a better response in the violet region of light. Experiments have been made with compound cells in which two cells made of materials with different response are placed at right angles with a coated layer of glass bisecting the included agle. One of the cells is turned towards the sun, but will receive only filtered light containing predominantly the wavelengths to which it responds. The rest of the light is reflected by the coated glass into the other cell which is chosen to have a matching response.

Even with simple cells there is plenty of scope to improve performance. Fig. 1 shows an idea that is now being developed by International Rectifier. A fine U-shaped wire conductor is embedded in the P-layer in order to reduce the internal resistance of the cell.

Temperature is an important variable in the performance of solar cells as shown in Fig. 3. As the conversion efficiency of the cell is between 5 and 14 per cent, over 80 per cent of the incident energy must be rejected in order to maintain good performance. For satellite applications, where radiation is the only means of heat rejection, special coatings have been developed that improve the ratio of absorbed to reflected heat. The cells are also quite sensitive to the accumulation of dirt, which will be a problem in remote signalling applications.

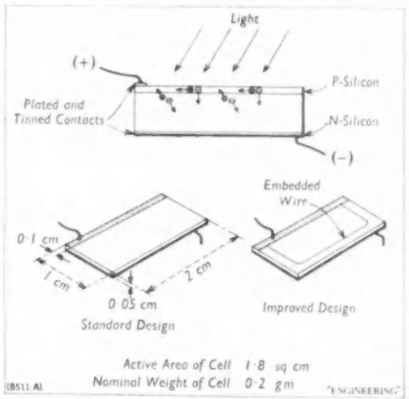


Fig. 1 (top) The difference between a solar cell and a transistor is in the thickness of the P-type layer, which is only about 2 microns.

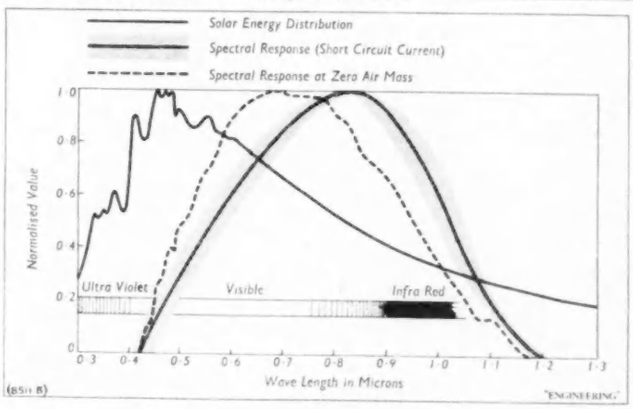


Fig. 2 (left) The maximum conversion efficiency of a solar cell is determined by the light spectrum and the cell response.

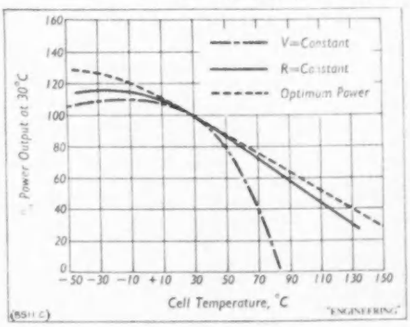


Fig. 3 (below) Some 85 per cent of the incident energy must be removed from the cell to prevent a rise in temperature, and hence loss of performance.

CHEAP CELLS

Perhaps more promising than the attempt to improve efficiency is the possibility of reducing manufacturing costs. Semiconductors are now produced by growing a single crystal about 1 in diameter and sereral inches long and cutting it into thin slices. The narrowest practical abrasive cutter is 0·020 in thick, so that about half of the carefully grown crystal is lost as "sawdust." Attempts are now being made to grow the crystals to the right shape from the beginning and thus eliminate cutting. Vapour deposition of material on to a flat surface appears promising, although the performance of the semiconductor thus produced is inferior to normally grown crystals. But if mass production by vapour deposition turns out to be really cheap, then an efficiency as low as 5 or 6 per cent could be easily tolerated in applications where weight and surface area are not at a premium.

Solar cells are expensive, and the expense limits the scope of immediate applications. An array of 15 standard cells, producing of the order of ¼ watt under favourable conditions, may cost £7. With no moving parts, the lifetime of the cells is only limited by mechanical damage and deterioration of electrical connections. Three years may be regarded as a conservative estimate, and since the fuel is free and maintenance negligible, the generation costs can be estimated. With medium efficiency cells the cost of electricity is less than 35*s* per kWh, which is below the cost of flashlight batteries.

The most promising field of application is clearly in the watt-range, but where operation is continuous the cost of electricity storage (for night or dark days) must be added. It is expected that once the solar cells are in mass production, the power costs will be reduced to less than 1*s* per kWh, so that electricity storage will be the ultimate limitation to cost reduction.

International Rectifier are now searching for suitable applications in two directions. The ability to recharge storage batteries using solar cells points to all devices where batteries are now used, preferably in remote areas. Signalling equipment, weather recorders, clocks, radios or hearing aids all come into this category. The Bell Telephone Company operate a rural telephone system in Georgia with 200 subscribers which is powered by solar cells, and portable two-way radios for sportsmen are being tried experimentally.

But silicon cells can also be regarded as photo-sensitive devices. The first commercial application of a silicon solar cell is in a flashing beacon for road signs which is shut off by a solar cell whenever there is enough light to see the obstacle anyway.

As transducers, the cells could be used in computers to convert signals from a punched tape into electrical impulses. The same principle can be utilised in process control, counting and other applications requiring light sensors.

The cycle of wider applications reducing unit cost, which in turn further widens the field of application, has only just begun for the solar cell. The chief competitor in the auxiliary power field will be thermoelectric generation from the decay heat of radioactive isotopes, which requires no storage for continuous operation. But the extreme lightness and simplicity of solar cell panels should ensure a good competitive position.

Standard Forms Aid Overseas Contracting

A common form of contract serves to indicate the legal basis on which tenders are invited; helps to eliminate omissions; and may save much trouble and expense. The B2 form of contract for exports of electrical plant has recently been revised.

By F. H. B. Layfield

One of the most striking trends in the realm of engineering contracts over the last twenty years has been the widespread adoption of standard forms. This practice has great advantages. The use of a common printed form makes for uniformity. It is often sufficient to say, in an invitation to tender, that a specified standard form is to be employed and that alone provides a fair indication of the intended legal basis. The use of such a form makes for completeness because a form which has been found adequate over a period of years is less likely to have serious deficiencies. Last, but certainly not least, the use of a common form can save much trouble and expense.

These advantages are most clearly seen in specialist fields where technical requirements should be closely reflected in the contract documents. This need was recognised by the Institution of Electrical Engineers earlier in the century who began to produce specialised forms of contract for use in cases where electrical plant and work figured prominently in the projects concerned. In 1925 the Institution published the " B2 Model Form of General Conditions." These were intended to cover the main conditions for export contracts (excluding cable contracts) for the supply of plant and the execution of work in that connection.

INSTITUTION SPONSORSHIP

This B2 form was revised in December, 1928, and there after remained unaltered for more than 30 years. In the intervening years much contract experience has been gained, especially in the realm of electrical work. It is not surprising therefore that the Institution have recently felt that the time had come to prepare and publish a completely new edition of this form of contract.

It has become increasingly clear over the years that in many contracts the interests of mechanical and electrical engineering were so closely interwoven that the legal form of agreement should recognise that situation. Opportunity has therefore been taken by the Institution in preparing the new form to consult with the Institution of Mechanical Engineers; in the result the form is sponsored by the councils of both institutions. The Association of Consulting Engineers have also indicated their support for the new form.

The old B2 form made provision for complete erection of the contract works. This involved the inclusion of many passages in the general conditions which were applicable only to erection matters and these passages cluttered up the form when often they were not needed. What is more, when a contract was made involving complete erection the form was not always found satisfactory or sufficiently complete for that purpose. Accordingly in 1954 a new and separate form for complete erection contracts was published and called " Model Form B3." The new edition of B2 is thus able to dispense with the complete erection provisions, though it still includes arrangements for supervision. The position is summarised by the councils who say " the present Model B2 was prepared for export contracts including delivery *f.o.b.*, *c.i.f.*, and *f.o.r.* with supervision of erection of mechanical or electrical plant."

There are some useful new additions to the published document. A " Memorandum on the Use of the General Conditions of Contract (B2) " is now provided. This is a good idea long since employed in other common forms. It is useful and informative so far as it goes. But it is the greatest pity that better could not be done. The committee seem to have been unable to decide whether the memorandum was to be addressed to those with no knowledge of the law of contract or whether it was intended to be used by the experienced who need only an *aide memoire*.

Very much the same may be said of the second addition to the document namely the " Memorandum as to Tenders." Once more this is a useful addition but it is distinguished more by a family resemblance to other standard forms than by any fresh contribution of its own. It contains brilliant glimpses of the obvious such as " the purchaser does not bind himself to accept the lowest or any tender . . . " while repeating much material of doubtful value, possibly because it appears in other and earlier memoranda.

RIGHTS AND OBLIGATIONS

Two other additions have been made which are an undiluted gain. A useful brief index has been provided and a model form of agreement has been appended. As regards the latter, one word of caution is perhaps worth while, especially in view of the drafting of the general conditions. The agreement recites the fact that the purchaser desires certain things to be done " as mentioned . . . in certain General Conditions, Specification, Schedules, drawings, plans, schedules of price, the Contractor's tender and covering letter (if any), the acceptance of the tender, and *any other relevant correspondence* . . . " The General Conditions define the " contract " as meaning " the agreement between the Purchaser and the Contractor for the execution of the works . . . including therein all documents to which reference may properly be made in order to ascertain the rights and obligations of the parties under the said agreement."

There is, of course, nothing wrong with these provisions. Yet the function of a written contract is, among other things, to make matters so clear that later argument is avoided. When it is borne in mind how many letters are sometimes exchanged in reaching detailed agreement the dangers of the passages just quoted are apparent. That this danger is not imagined may be seen in the case of *Davis Contractors Limited v. Fareham UDC*, where the question whether or not a single letter formed, or did not form, part of the contract was only resolved by the House of Lords.

WHAT DOCUMENTS ARE SPECIFIED?

A small footnote is added to the model agreement saying, in regard to the passage quoted above, " Delete as required " and reference is made to the explanatory memorandum. The matter should, however, be watched with particular care and it may be that the earlier B2 form which, in the definition clause listed in contract documents by name, was in some respects safer. Anyone using the form would be well advised to ask himself before he signs: what are the contract documents and are they, and they alone, specified in the formal document I am signing?

The clauses of the general conditions have been extensively redrawn. The sequence of subjects has been changed and is the better for that. By and large the provisions have been improved and are made clearer and more exact. A good deal of tidying up has also been done. For example, the provisions relating to defects liability were to be found in the old form in Clauses 23, 34 and 36. In the new form these provisions have been gathered together under one head in Clause 23.

It was not clear in the old form whether the warranties and conditions which the general law implies in certain contracts were excluded by the provisions of the standard form. Probably they were not, since the courts have said that these implied conditions and warranties can only be excluded by very clear words.

CONTRACTOR'S LIABILITY

The draftsman has clearly excluded them in the new form by providing a new sub-clause (viii) to Clause 23 which states that:

> " the liability of the Contractor under this Clause shall be in substitution for and to the exclusion of any warranty or condition implied by law in respect of the quality or fitness for any particular purpose of the Plant delivered."

This addition should be noted since there may well be occasions in which it may prove significant.

There are a number of other additions to the clauses. These are mostly minor and consequential upon reorganisation of the contract. Engineers may care to note that under Clause 8(ii) they are now given express power to delegate their powers under the contract provided this is done in writing and a copy served on the contractor. They may also wish to note that where the purchaser furnishes a design to the contractor, and this will doubtless often be his engineer's design, then the purchaser by Clause 7(iii) now expressly " warrants that any design or instructions furnished or given by him shall not be such as will cause the Contractor in the performance of the contract to infringe any letters patent, registered design, trade mark or copyright in the country in which the Plant is used."

AVOID CONFLICTING CLAUSES

The revised form is a great improvement in two ways. In the first place it is a more coherent and better drawn document. Secondly, being new it inspires more confidence. As Lord Justice Devlin pointed out in *Windsor RDC v. Otterway & Try Ltd.*, when considering two conflicting clauses in a standard form, " if one is permitted to use one's experience, or even one's common sense, as to how these contracts are built up, I think it is clear enough how the two clauses came to be there. The contract is not one that has been drafted as a whole and fully formed at one given moment; it is a contract which is built up from time to time by clauses being added." The outstanding merit of a new form is that it goes some way to obviate such dangers.

The advantages of a form like this are very real but so also are the dangers. Among the latter is the fact that it may be too readily assumed that the form will fit all circumstances. Of course it cannot and the Institution in recommending the General Conditions are careful to add that " they may, however, be added to or amended as may be required to suit each particular case. In order to facilitate checking, it is recommended that if the Conditions are reproduced with additions and alterations these should be made so as to attract attention." To this sound advice it should also be added that when such changes are made care should be taken to see if they are likely to clash with or affect any of the remaining unaltered clauses. Failure to make such a check is one of the pitfalls presented by even the best of standard forms.

EDITORIAL NOTE

" Engineering Contracts " were the subject of a series of articles by Mr. F. H. B. Layfield published in ENGINEERING (vol. 182, 1956, pp. 137, 201, 265, 329, 393, 457, 521, 585, 649, 713, 745, 777 and 811). The series is available from ENGINEERING, 36 Bedford Street, London, WC2, as a reprint, price 8*s* 6*d*.

Human Element

Union to Promote Employers' Product

AN unconventional use of union funds, that would raise no eyebrows in the United States, has cropped up in Nottingham where lace workers are to spend £1,000 of their union funds in advertising lace products.

The common-sense observation "The prosperity of the industry is just as much our responsibility as the manufacturers'," was made by the secretary of the Amalgamated Society of Operative Lacemakers, Mr. John Flewitt.

The union's secretary takes the edict of Mr. Alfred Robens, once the Labour Party spokesman on labour affairs, that the strike is an archaic weapon, a stage further. Mr. Flewitt has declared "Hoarding union money to spend on strikes is outdated."

Other unions have taken to spending money advertising their advantages. There is no evidence yet of other unions following the lace workers and, for instance, seeking export orders.

A Trend Towards National Wage Equality?

Equal pay for equal work has long been the slogan of the campaigners for higher pay for women.

It looks now as if the emphasis may increasingly be upon the equal work and that application of the idea will spread, not only in womens' employment but among the working population in general.

The Guillebaud report, based upon comparison with outside, comparable and therefore in a sense equal work, has now been brought into application on the railways. Certain unseemly tussles on the fringes of the Transport Commission's preserves only indicate that if all jobs are equal to something, some are more easily seen to be equal than others.

Not without criticism the Civil Service pay research unit has settled down to its work and been very broadly accepted. Now come the first signs of the movement for work comparison as a way of determining wages beginning to spread.

As so often happens in union matters the transport men are giving a lead. The London busmen are urging that there should be a Guillebaud inquiry into their rates of pay, overtime and special conditions.

Large and Small

But the United Kingdom is a land of small firms, the proportion of the working population employed by the giants, by AEI, English Electric, ICI, Hawker Siddeley, is tiny compared with those in companies employing 50 to 100 people. In the engineering industries national bargaining has eliminated the significance of this difference but the difficulties of work comparison would be enormous.

Certain groups are unique. What job compares with coal mining, or agricultural labouring, or shipyard welding? By functional description such jobs stand apart, but as work comparison gains ground the underlying relationship that links all these operatives together must be taken into account.

For many millions of the working population responsibility ends with carrying out the order of a foreman. Acting, or not acting, in the correct manner affects only the limited field of the individual operative's work.

At this level all these diverse activities are equal, a fact recognised in the traditional broad similarity of reward. As job comparison gains influential supporters this view of its application may gain ground.

The obvious benefit of action along these lines in tidying up the infinitely complex pattern would be the reduction of the tendency for one wage claim to leapfrog the claim in front, setting up pressure from the leapfrogged to do the same, *ad infinitum*.

Yet all this could take a century to become broadly accepted. For how far extends the responsibility of the unskilled man carrying out a simple assembly line function in a car works? If he fails in his humble task, which is all he is paid to do, the whole line may come to a halt. Even if it does not, the eventual finished car may develop an expensive fault months after, with local damage to the company's name and even possibly loss of life.

Facts like this would be sure to be put to any pay research committee on the engineering industries, and it would be a brave man who sought to draw the conclusions.

From Graduate-apprentice to Manager in 15 Years

Mr. James Gavin Warnock who, as reported on our Companies page this week, has been appointed manager of English Electric's new hydroelectric division, was born in London on 28 May, 1925. He graduated from Glasgow University with first class honours in mechanical engineering and joined the company as a graduate apprentice in May, 1945.

During his apprentice training he was sponsored by the company to attend a post-graduate course in hydroelectric power engineering at Imperial College, London, and in December, 1947, was appointed assistant designer in the hydroelectric design department. In June, 1950, Mr. Warnock became assistant project engineer in the hydroelectric design section at Rugby and, in January, 1952, project engineer at John Inglis in Toronto. He later became manager of John Inglis's hydraulic department.

Pye Take-Over Not to Affect Temco Staff

Mr. C. Stanley, the chairman of the Pye company, victors in the battle to take over the Telephone Manufacturing Company (Temco), has assured its 3,000 employees that their future will not be adversely affected. Indeed, Mr. Stanley sees the position in an even brighter light. He has told the Temco chairman, Mr. C. H. Jackson, that the position of his men and women will be improved as members of a larger organisation.

Mr. Jackson continues as chairman of the company and Pye are to appoint one of their directors as vice-chairman.

As an entry to Post Office work, and with the bounding Pye enterprise behind it, Temco may well be the scene of vigorous development in the future.

United Steel Not Joining State Pension Scheme

The United Steel Companies, after consultation with its employees, is to contract out of the graduated state pension scheme. The decision will apply to all members of the staff and the works pension funds.

United Steel explains that both funds are contributory. Membership is a condition of employment for all over the age of 21 who have completed the company's qualifying period.

The only material alteration in the conditions of the funds has been the raising to 25 of the entry age for women.

Take Your Work Study Problem to Loughborough

Realism is to be brought to the courses in work study and method study at Loughborough College of Technology, Leicestershire, this autumn by the use in group studies of problems from the organisations sending their employees.

Loughborough is obviously making a substantial contribution to the study of both subjects in bringing together a large number of industrially employed staff whose most important qualification for the courses will be ability to benefit from them.

The College suggests to sponsoring companies that they should put forward staff with suitable personal qualities, enough initial technical knowledge, and who are familiar with the processes and practices of their own particular fields.

The first, and briefest, course lasts two days, 21 and 22 September, and concerns management appreciation in work study. This is to acquaint directors and general managers with the contents of the succeeding longer courses. This has two purposes: to enable the executives to assess the value of the courses and to make the fullest use of staff who attend them.

For ten weeks, 26 September to 2 December, the main course in work study will be taking senior staff through lectures, demonstrations, discussions, laboratory work and actual projects in industrial works and offices. The College point out that not even the ten week course can give the full training for a work study practitioner.

Experience

Intensive practice on the job is necessary and it can be arranged for those who have taken the course to be placed with a suitable company for three months under trained supervision.

More briefly, from 26 September for three weeks, the basic course in work measurement goes from the history of work measurement through a variety of work study subjects, including the application of work measurement to automatic and flow production processes, and work measurement as a basis for financial incentives, to work measurement as a basis for managerial control.

A further basic course, of three weeks from 17 October, handles a number of the fundamentals and practices of method study.

The advanced techniques course in work measurement, from 7 November for two weeks, includes consideration of rating technique, statistical methods in work measurement, the use of work measurement as a basis for financial incentives directed to maintenance and clerical work, and among other subjects, developments in the conduct of formal relations between trade unions and management.

For two weeks, ending on 2 December, the method study, advanced techniques, course will include applications of method study to non-repetitive work, ergonomics, a number of economic considerations in production, photographic techniques, cybernetics as an advanced management technique, linear programming, and various considerations of communications.

Finally, from 5 to 9 December, a course for departmental managers, foremen, technical specialists and shop stewards will seek to acquaint this cross-section of those who come into contact with work study with its aims, methods and purposes.

New Association of Management Teachers

Out of last month's Pembroke College, Cambridge, conference has emerged a new body for those concerned in the teaching of management skills. To be known as the Association of Teachers of Management, it has three membership groups. They are:

Founder members—management teachers who were members of the European Productivity Agency and Birmingham groups supporting the Pembroke College conference.

Industrial members—people engaged on management education in business and the public services who are invited by a member and approved by the executive committee. And

Academic members—People with suitable academic or professional qualifications who are responsible for teaching on advanced management courses of graduate or post-graduate standing, such courses being supported by "serious" management research work, or people responsible for directing such research work.

While broadly aiming at raising the professional standards of management teachers, the new body intends to encourage management research and the development of management education; to provide for the exchange of ideas, research findings and experience, and to assemble and represent the views of members on common problems.

Technical Training awards in New Zealand

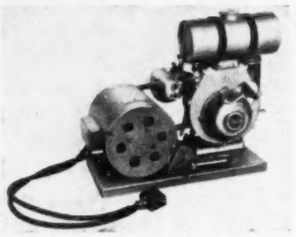
The Simms Motor Units Awards, to the outstanding students in auto-electrical and auto-diesel studies in the North Island of New Zealand, have again been presented this year.

The awards were first offered some years ago by the managing director, Mr. E. H. Nelson Mee, of Simms Diesel and Electrical Services, who are agents for Simms Motor Units in the North Island.

The presentation is made to the two students when they attain their final trade certificates for which examination are held under the authority of the New Zealand Motor Trade Certification Board.

PORTABLE GENERATOR

Stabilised Output



THE latest addition to the Abem range of portable generators is model GA-1186 which has an output of approximately 600VA.

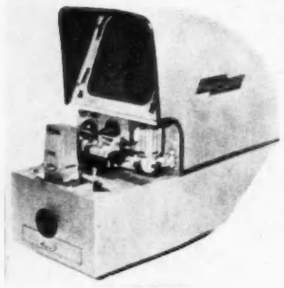
The set consists of two parts, the engine and the generator. The two clamp together and the drive is by belt. The engine is an ILO-175 air cooled single cylinder unit which will develop 2·2 h.p. at 3,600 r.p.m. It is fitted with an air filter, a silencer, rewind rope starter and an adjustable governor that will maintain speed constant to within 2 per cent. A full tank of 2·3 litres is sufficient to run the set for 2 hours at maximum load. The weight of the unit is 14 kg or about 30 lb.

The generator is a two-frequency machine using a twin rotor with two sets of permanent magnets and a stator with two single phase windings. It is rated for a maximum current of 3A and there is provision for nominal voltage outputs of 100, 200 and 300V. The two standard frequencies are 660 and 220 c/s; others can be supplied on request. It weighs 19·5 kg (46 lb). A control box with voltmeter ammeter and frequency indicator, overload fuse and switches complete the equipment.

The two main items can be mounted on carrying frames (weighing 4½ lb each) which can be slung on the shoulders. No additional tools are needed for clamping the units together on site. The set was originally designed for use with the firm's Turam and Compensator equipment for ore prospecting by electroinductive methods but can be used for any other application where a stable a.c. supply is required. *AB Elektrisk Malmletning, Danderysgatan 11, Stockholm, Sweden.*

PROJECTOR

Profile Comparator and Episcope



THE Revelation is one of the series of Magnotic comparators for bench and toolroom work.

The other units are the Heliscope for simple direct comparison and the Vertex, which is essentially a reflex version of the former with an enlarged screen.

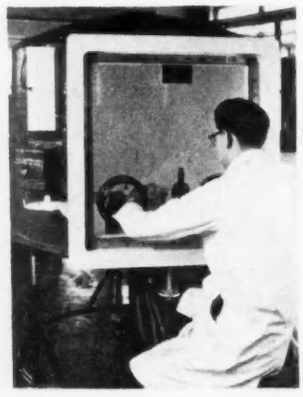
The Revelation is designed for inspection work and has four magnifications: ×10, ×25, ×50 and ×100. Corresponding field diameters are 1·2, 0·5, 0·25 and 0·12 in. Achromatic lenses are employed and green filters incorporated to reduce eyestrain. The optical system gives sensibly constant illumination across the parallel beam, light being supplied by 100 watt lamps working on 12 V a.c. lamps.

The compound work table is hand finished and has a large diameter drum micrometer, both for adjustment and measurement. The screen is 13 in by 12 in and the field projection is 10 in diameter. The worktable is 8·5 in by 3·5 in with 2·5 in travel fore and aft and 0·75 in transversely. There is a vertical adjustment of 2·5 in.

The lamphouse for profile projection is centrally mounted, and those for surface and deep hole projection one each side beneath the viewing screen. The table is placed centrally in the triangle. The screen is fine textured etched glass with four pivoted spring fingers for clamping templates. A protractor can be fitted instead. *Heston Aircraft and Associated Engineers Limited, Hounslow, Middlesex.*

GLOVE BOX

Glass Fibre Construction



RECENTLY introduced, the Secray Mark III glove box has glass fibre construction with a turntable for the working surface.

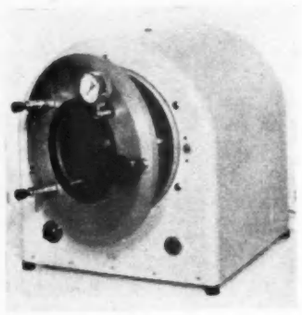
The box was originally designed for radioactive and other toxic materials. Glass fibre construction has made it corrosion resistant and also reduced the weight. In the standard model, two 6 in glove ports are provided in the main window giving access to an illuminated rotating table. An 8 in bag port allows for passing components into the box.

At the centre of the dome shaped roof is a 6 in explosion port sealed by a rubber ball which will lift if the internal pressure exceeds 1 in water gauge. A bag ring is provided to enable the released gases to be evacuated through the laboratory extraction system. A partial vacuum of 4 in water gauge can be maintained inside the box by an ejector vacuum pump. A Vokes extract filter is fitted inside the box.

The whole box is mounted on a tubular stand with castor wheels. The turntable is a polyester moulding and is carried by six castors clear of the inside floor to allow for decontamination. It can be locked by a foot brake. All leads pass up the central column through the rotary seal. Outside dimensions are 6 ft 8 in high by 4 ft 3 in diameter. *Seton Creagh Engineering Limited, GW Trading Estate, London, N.W.10*

VACUUM OVEN

Glass Fibre Body



THE new range of DAG vacuum ovens has been designed for both laboratory and general use.

The interior is made of anodised aluminium and is electrically heated. Temperature is controlled by a thermostat. In the aluminium alloy door is an observation window through which progress can be watched. The door is hinged so as to give a self-centering action and is fitted with a quick acting fastener. The arrangement of the shelves can be varied to suit special requirements.

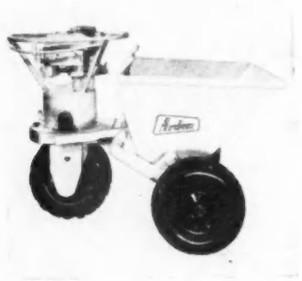
On the door are fitted two vacuum taps and a vacuum gauge calibrated in inches and millimetres. Thus all pipe work is eliminated and servicing reduced. The thermostat control and an indicator light are fitted on the front of the oven. A dial thermometer can be provided.

The ovens are made in three sizes. Type 1 has interior dimensions of 12 in diameter by 12 in straight length. Two shelves are fitted, the distance between them being 4 in. The temperature range that can be covered is from ambient up to 150° C; the thermostat gives control to within 2° C. The maximum vacuum obtainable is 30 in. The oven measures 18 in wide by 22 in long and stands 21 in high. It is normally supplied for alternating current of 100/120 or 200/250V, 50 cycles.

Type 2 oven is generally similar, but the interior dimensions are 15 in diameter by 18 in deep. Type 3 is the same as type 2, but has a door each end. *D. A. Gunn (Engineering) Limited, Park Road North, Acton, London, W3.*

POWER BARROW

7 cu. ft Capacity



THE power barrow illustrated has a capacity of 7 cu. ft heaped or 5 cu. ft level for liquid.

It is designed as a general purpose machine for use on building sites, factories, market gardens, nurseries, or farms. It is claimed that it will do the work of three men using hand wheelbarrows, and cause less operator fatigue. No previous experience is required to operate it.

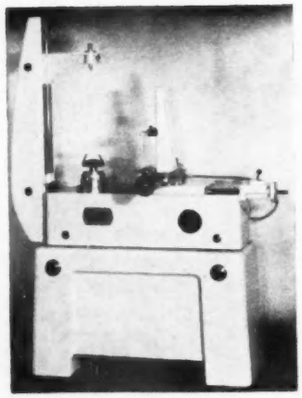
The only control is the clutch lever; with this disengaged the barrow is locked even when standing on a downhill slope. If it is required to shift it by hand, a dog can be disengaged freeing the driving wheel.

Power is supplied by an air cooled petrol engine rated at 3½ h.p. when running at the governed speed. Fuel consumption is approximately 1 gallon per working day. The entire power unit is mounted on the drive wheel assembly which can be turned through 360°, allowing the barrow to turn in its own length.

The maximum payload that can be carried depends on the road surface to be traversed and the gradients to be negotiated, but ranges up to between 5 and 7 cwt. The bucket is tipped by a single hand lever (needing only one hand to operate it) and on return to normal position is automatically locked. The overall dimensions are 54 in long by 41 in wide and 39 in high, and the weight is 260 lb. *Arden Plant Limited, Sopers Lane, Poole, Dorset.*

INVOLUTE TESTER

Takes Gears up to 24 in Diameter



THE No. 3 involute tester is a larger machine than the No. 2 and will take gears up to 24 in base circle diameter.

The maximum weight that the supports will take is 1,000 lb, and shaft and arbor mounted gears can be accommodated between centres up to 18 in diameter and 24 in long. The machine stands on a Meehanite pedestal and is suitable for use on 110 or 240V 50-60 cycles supplies. The stylus moves 12 in vertically.

A disc of diameter equal to the base circle of the gear under test is mounted coaxially with it, and the straight edge carrying the indicating mechanism bears against this disc. The straight edge is moved by power or hand and rotates the gear; the stylus follows and gears against the tooth profile. Any deflection of the stylus shows a deviation from an involute and is recorded electronically. A straight line shows a true involute.

Special features of the machine include taper roller bearings with a bore of 2 in on the spindle that carries the gear under test. A quick withdraw attachment enables the stylus assembly to be withdrawn 1½ in so that gears can be loaded without risk of damage. The stylus head is sensitively balanced to retain the accuracy of the electronic recording while the bias allows both flanks of the gear to be checked. *J. Goulder and Sons Limited, Kirkheaton, Huddersfield.*

WELDING METER

For Efficiency and Costing

RECENTLY announced is a welding meter for measuring the electrical condition in a welding arc.

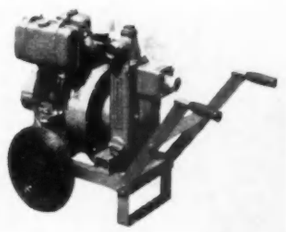
The instrument can be used for costing, calculating efficiency and improving production techniques, as for example in determining the ideal cooling rate for various metals. The unit consists of a watthour meter, ammeter, voltmeter, and protective relay all housed in a compact case measuring 16½ in by 5⅝ in. by 6½ in. It is suitable for switchboard or wall mounting. From the meters the arc voltage and current and the total energy consumption can be read directly.

The relay is incorporated to give protection against over-current in the event of the meter being used with an incorrect current transformer ratio. A four range current transformer for stepping down the current from 100, 300, 500 or 1,000 A to 5 A can be supplied for use with the instrument. This gives coverage for most welding currents.

The watthour meter has a pointer which moves over a 4 in diameter scale, one revolution of the pointer being equivalent to 100 watthours at a transformer ratio of 100/5. For other ratios a multiplying constant must be used. The pointer can be reset to zero after each welding operation by depressing the knob in the meter glass and turning anticlockwise. The total watthours are recorded on the meter register. The ammeter and the voltmeter are of the 4 in square moving iron pattern. Zero adjusters are accessible through cover plates in the meter window. The voltmeter is scaled 0 to 120 V and is marked 1 volt per division between 20 and 45 volts which is the normal arc range. The ammeter is scaled 0 to 120 A and reads direct for a transformer ratio of 100/5. For other ratios a constant factor must be used. *English Electric Company Limited, Marconi House, Strand London, WC2.*

PUMPING SET

10,500 Gallons Per Hour



A RECENT addition to the range of pumping sets is the model 2D2 which will deliver up to 10,500 gallons per hour.

The pump is a 2 in model and will work against a maximum total head of 88 ft. At 80 ft head the delivery is 3,000 gallons per hour, rising to 8,300 g.p.h. at 50 ft and to over 10,000 at 30 ft. The delivery of 3,000 g.p.h. at 35 lb per sq. in makes the unit suitable for spraying purposes.

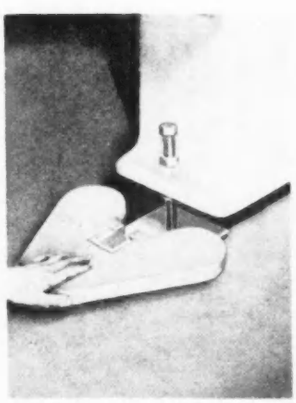
The pump is self priming up to the maximum suction lift without levers or valves. It will operate on sandy or muddy water. The chamber is available in several materials to suit the liquid being handled, and renewable wearing plates are fitted. The impeller is of the open trash type screwed to the shaft and can also be made in materials to suit requirements. The seal is a dual-faced oil-immersed unit housed in an oil reservoir outside the chamber, keeping it free from the liquid being pumped.

The engine used for the set is an Enfield model 350 air cooled single cylinder diesel, developing 4·5 h.p. at 3,000 r.p.m. It is close coupled to the pump, which with the design of seal, gives a very compact unit. A governor override is fitted to allow the pump to run as efficiently on snore as on full bore, as well as cutting down the fuel consumption.

The standard unit is mounted on a steel trolley as shown, with two rubber tyred wheels. Handles, leg and axle are removable for packing. Complete, the set weighs 360 lb. Other types of mounting are available. *Goodenough Pumps Limited, 112 Jermyn Street, London, SW1.*

SKATE

For Machine Transport



THE Vulca-Skate is designed to enable heavy machines to be moved with the minimum of lifting.

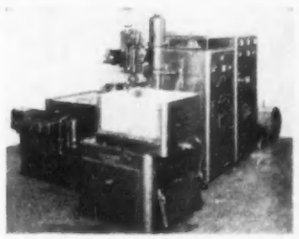
Basically it consists of a heart shaped steel plate with three castor wheels. Each of the castors is mounted on a ball bearing and can therefore swivel with ease. The safe working load of a Skate is 1½ tons so that machines up to a total weight of 6 tons can be carried on four Skates—one to each corner or foot.

To use, the machine is first raised a matter of 3 in to allow the Skate to be slid under, and then lowered on to it. The machine can then be moved about the shop as required for the change in layout, or to the maintenance shop for overhaul. Lowering is equally simple.

When machines are standing on Level-Mounts, the procedure is easier: the lock nuts on the supporting screw are slacked off and the machine jacked up by turning the screw with a spanner. The Skate will run over the plate of the Level-Mount and the machine can be lowered by the screw. Inserts are available to fit in the recess of the Skate to suit the three sizes of Level-Mount screws, ¼ in, ⅜ in and ½ in. The wheels of the Skate will straddle plates of 3 in by 3 in or 6 in by 6 in and nuts of the screws lock to steady the machine. *Vulcascot (Great Britain) Limited, 87 Abbey Road, London, NW8.*

SPARK EROSION MACHINE

Large Work



THE Sparcatron Mark V machine has a capacity for handling large workpieces.

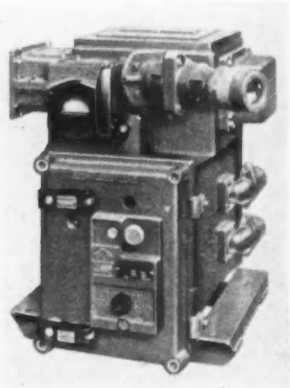
The machine has a work tank measuring 32 in by 24½ in by 16 in deep and a table area of 28 in by 22½ in. It holds 44 gallons of electrolyte. It is mounted on an adjustable sub-base with a lateral adjustment of 12 in. Micrometer dials are fitted graduated in 0·001 in divisions. There are four quick acting clamps for locking the sub-base in position.

The servo-head is mounted to swivel on the column and has a back and front adjustment of 10 in. Again there is a dial graduated in 0·001 in divisions. The head can also be tilted with respect to the vertical. The spindle is mounted in pre-loaded recirculating ball slides and a drive from the servo-motor is taken through gearing and a coarse pitch screw and nut which is fitted with backlash compensation. Electrodes up to 50 lb in weight can be used and there is an adjustable spring balancing arrangement for the electrode and spindle. A vernier covers the full servo stroke of 6 in and limit stops are provided. The head has a vertical adjustment of 10 in. The minimum distance from the spindle nose to the sub-base is 11¼ in and the maximum is 27¼ in.

Power is supplied by two units: a type RIG for roughing and a finish control cabinet for fine work. The RIG operates in conjunction with a rotary rectifier but the finish cabinet has metal rectifiers contained inside it. Removal rates are up to 6 cu. in per hour. Fume extraction and electrolyte circulating and filtering plant can be supplied for the machine. *Impregnated Diamond Products Limited, Tuffley Crescent, Gloucestershire.*

GATE END BOX

Breaking Capacity 240A



THE SGU30 gate end box is a flameproof unit for the control of small motors.

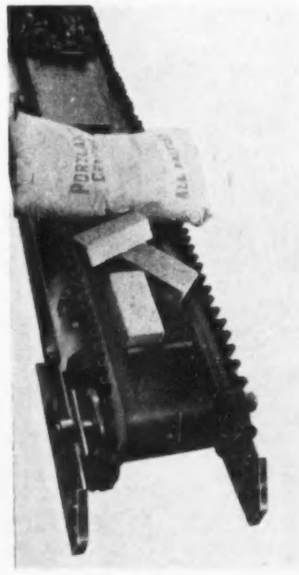
It is fitted with earth leakage protection, an intrinsically safe earth leakage lockout circuit, and low voltage control circuit. Two auxiliary side sockets are provided for remote control, and sequence facilities are fitted.

The welded steel case is divided into two compartments. The upper compartment contains a triple pole reversing isolating switch with a tested breaking capacity of 240A at 650V, 0·25 power factor, and the outgoing busbars which have a continuous rating of 300A. The lower compartment contains the contactor and its control and protective equipment which are mounted on a withdrawable chassis for ease of maintenance. The contactor is continuously rated for 30A and will make and break 240A at 650V, 0·25 p.f. The contacts are enclosed by arc chutes eliminating the need for blow-out coils.

Overload protection is provided by a triple solenoid operated relay with two-rate dashpots. Earth leakage is covered by a ring type core balanced transformer and relay which trips at 2·5A. The lockout circuit ensures that the contactor cannot be closed while there is a fault on the outgoing line. *Belmos Company Limited, Bellshill, Lanarkshire.*

CONVEYOR BELTING

Corrugated Sides



IT is claimed for a new conveyor belting that the corrugated sides increase the capacity and possible working gradient.

The belting is being made in standard widths from 9 in to 36 in and with corrugated sides of either 2 in or 3 in high. It is constructed of rubber and canvas, the number of plies being chosen for the load.

The corrugated sides form tough walls on the straight without tension at the ends, and they increase the load carrying capacity by 25 per cent for 2 in height and by 50 per cent when 3 in high. The side walls also allow an increase in the working gradient up to as much as 25 per cent, depending on the material being handled; an increase can also be obtained by rubber flights. A site test showed that ½ in small coal could be elevated at an angle of 40° without difficulty. Another economy is that one parallel idler will replace from three to five troughing rolls. *Numec Limited, New Whittington, Chesterfield.*

Founding a Bridge Abutment on a Fault

Wentbridge Viaduct proved to be so sited that the south abutment is above an unrecorded fault in the sandstone. A drilled concrete foundation 60 ft deep has been constructed.

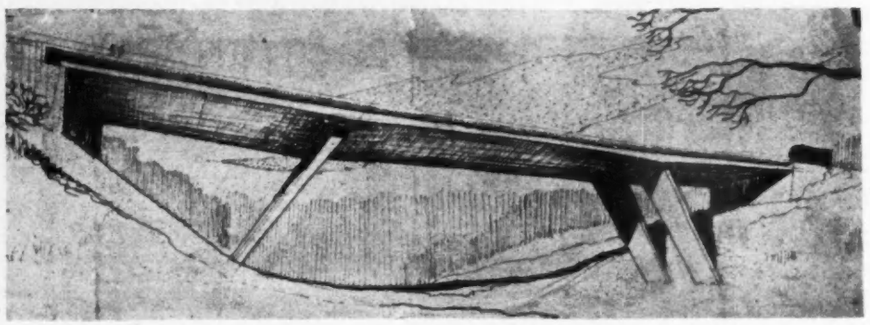


Fig. 1 Architect's sketch of Wentbridge Viaduct.

IN THE preliminary designs for the Wentbridge Viaduct it was proposed to construct the abutments on drilled concrete foundations above a sandstone bed. When drilling reached the expected foundation level the sandstone had not been met and what had been thought to be a straightforward foundation job turned out to be exceedingly difficult.

In fact, the formation of the Middle Coal measures on this site proved unexpectedly complex, arousing considerable interest among local geologists and, though various opinions have been put forward to explain the conditions, the weight of evidence now appears to indicate that a major fault, the presence of which had not previously been recorded, crosses the Went Valley in Yorkshire.

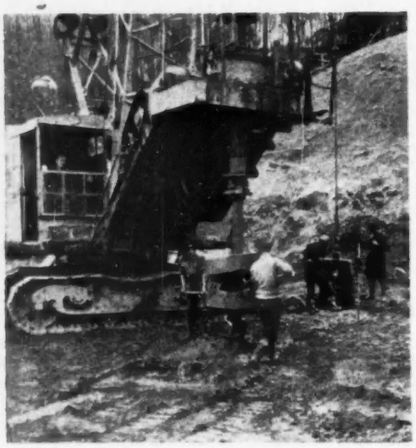


Fig. 2 Auger equipment, showing particularly the boring head. In the background, a Hochstrasser chisel (hung from a second machine) is being used to begin the excavation for a second shaft.

Economic Foundations Limited of 161 Victoria Street, London, SW1, who specialise in drilled concrete foundations, were engaged as subcontractors to sink deep cylindrical foundations for the south abutment for the viaduct, which is north of Doncaster and forms part of the A1 London-Edinburgh-Thurso trunk road. In charge of the contract, as agents for the Ministry of Transport, are the West Riding County Council, whose engineer and surveyor is Mr. S. Maynard Lovell, O.B.E., M.I.C.E. Taylor Woodrow Construction Limited are the main contractors.

SANDSTONE BED

The viaduct itself is illustrated in the architect's sketch on this page, Fig. 1. The main deck is of post-tensioned box girder construction continuous over three spans with cantilevered footpaths, and the inclined legs are to be of cellular reinforced concrete construction. The overall length of the viaduct between the butments is 476 ft and the propping points above the inclined legs are at 190 ft centres. The width of the principal box section construction is 61 ft and the overall width of the viaduct, including the footpaths, 78 ft 4 in.

Preliminary surveys had indicated a massive bed of sandstone at a suitable level on which to found the abutment, but when that level was reached during drilling it was discovered that the sandstone which was so much in evidence a few yards away had disappeared completely, though the overlying strata, with their approximately level bedding, gave no indication that this was the case.

Further borings indicated a very sharp dip of about 55° occurring locally in the sandstone stratum alone which was not reflected in either the overlying or surrounding measures. Because of the dip, the main bed of sandstone proved to be approximately 60 ft below the base of the abutment and lying at an incline, with bands of clay and medium to soft sandstone above it. At this stage of the contract and in the belief that the excavation area was free of water, the work of installing 4 ft 6 in diameter foundation cylinders, excavated by auger, was put out to tender and Economic Foundations' offer for unlined cylinders was accepted.

SUBTERRANEAN WATER

When piling was put in hand, however, subterranean water in large quantities was encountered at a depth of about 25 ft (less than half the piling depth). De-watering trials showed that in the circumstances it would not be practical to de-water the area and it became evident that drilling by auger, without the use of linings, could not be used to form a satisfactory pile. The shaft would have to be lined for the greater part of its length and, as the temporary lining normally employed with the auger system are only suitable for depths up to 30 ft 0 in, it was decided to introduce the Hochstrasser Weiss system for which Economic Foundations Limited have the sole rights in the United Kingdom. Changes in the design were then made to replace the 4 ft 6 in diameter augered piles by 1 metre Hochstrasser cylinders. The gross design load to be taken at foundation level below the south abutment is 14,350 tons and it was decided that 29 cylinders should be driven to support this load, i.e., very nearly 500 tons on each. All the piles are vertical, no rakers being employed.

In practice it was found that the best method of forming the piles was the combination of the two systems; by augering the shafts where possible and employing the Hochstrasser chisel and hammer grab where hard bands were encountered.

The auger equipment used, which is British designed and made, is illustrated in Fig. 2 and consists of a boring head mounted on a 43 RB. The square-section Kelly bar is chain driven through a rotary box and, to assist boring through hard material and withdrawing the auger, if held down by suction, a hydraulic unit is fitted above the boring platform to utilise the deadweight of the machine (50 tons) to exert extra pressure.

The Hochstrasser system is shown in Figs. 3 to 5. The principal component of the system, shown in Fig. 3, consists of the lining tube made of Corten steel with a swinghead at the top. In the case of Wentbridge, the tubes were 1 m in diameter and for a length of 60 ft weighed 4 tons each. The swinghead, which has an overall length of 15 ft and weighs about 3½ tons, is air-operated and oscillates through an angle of 30° (± 15° about the rest position). As the swinghead reaches the extreme of of its side travel it is brought to rest by a stop which transmits a shock load through the liner to assist driving. In the size of equipment used at Wentbridge the swinghead operates at approximately 25 blows per minute. To start the liner a 10 ft guide tube is first sunk in position and plumbed. This is sufficient to correctly locate and align a 60 ft liner ready for driving. The liner will then settle under the combined action of its own weight and the percussion load from the swinghead. Spoil is normally removed using a hammer grab, but if the material is extra hard it can be broken up using a drop chisel (Fig. 4). When foundation depth has been reached the concrete is fed into the tube from a skip.

To withdraw the liner, a sealing cap is fitted into the top of the swinghead and an internal pressure of approximately 15 lb per sq. in (gauge) maintained within the tube. This is sufficient to carry the deadweight of the liner. Friction forces round the side of the liner

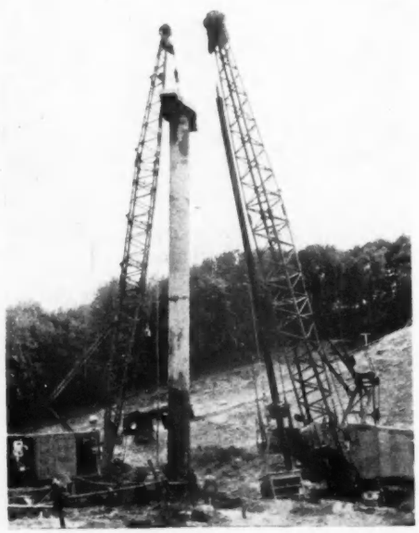


Fig. 3 A Hochstrasser liner (after withdrawal). At the top of the liner is the swinghead which, air-operated, provides percussion loads to assist in driving and freeing the liner. On the right is a second machine equipped with an auger but being used for concreting the shafts.

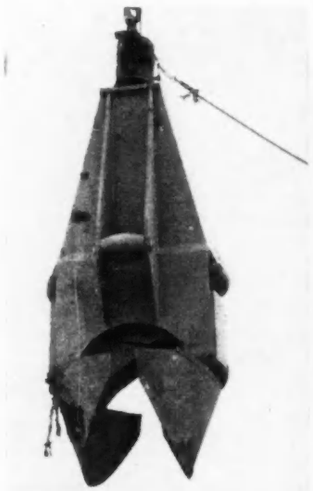


Fig. 4 (below) Hochstrosser chisel; it is fitted with vanes that cause it to turn as it drops through water, so increasing its effectiveness in breaking up hard material. (Left) A Hochstrasser hammer grab.

Fig. 5 (right) Fitting the sealing cap prior to withdrawing the liner. The illustration also shows in some detail the swinghead which is 15 ft long, weighs 3½ tons and is air operated.

are overcome by the direct pull on the crane hook, assisted by the swinghead. Occasionally, on very long piles, this operation is assisted by placing a pole under the jibhead and using a 5 reeve pulley system.

At Wentbridge, after excavating down to the main sandstone bed, the Hochstrasser tube was introduced as a temporary lining to retain loose materials and prevent them inter-mingling with the concrete being used to form the piles. Penetration of about 5 ft into the hard rock was obtained by excavating into the main bed, using the Hochstrasser chisels and grabs.

The concrete itself was carried out under water using tremie pipes. As the concreting progressed the lining tube was raised in three stages. The lift from the 43 RB was aided by compressed air and sometimes by a pole under the jibhead as just described, and the swinghead was also employed to break down friction between the liner and the concrete and between the liner and the surrounding stone and clay.

Economic Foundations claim that the project well serves to demonstrate the flexibility of cylindrical foundation construction with the two systems—auger and Hochstrasser—employed together.

Curtain Walling in the United States

Curtain wall construction was first devised and put into use by William LeBarron Jenney in Chicago in 1883. Jenney, together with John Wallborn Root and Louis Henry Sullivan, were three of the architects who were concerned with the reconstruction of that city following the disastrous fire in 1871. They were possibly the first to comprehend the architectural potential of the new materials then being introduced.

The work of these three became known as the Chicago School and Jenney's especial contribution, that of the steel frame structure, first used in his Home Insurance Building in 1883, became known as "Chicago construction." That was the first occasion when exterior walls did not support floor loads but acted purely as a cladding. Designers had realised that the structure's skeleton could be an architectural feature.

These early beginnings of curtain walling will be outlined by Mr. George Edson Danforth when he lectures on the curtain wall technique at an international symposium to be held at the Royal Institute of British Architects in London on 5 and 6 September. Mr. Danforth is a director of the Institute of Technology, Chicago, and chairman of the department of architecture at Western Reserve University, Ohio. For many years he has worked with Ludwig Mies van der Rohe. He is a special consultant to the United States Steel Corporation and, as such, has a special interest in steel curtain wall buildings.

There are now, reports Mr. Danforth, upwards of a thousand steel curtain wall buildings in the USA today. The particular advantage of the technique he ascribes to the ease and speed with which the panels can be put into position. In addition, porcelain enamel sheets are virtually maintenance free, requiring no more than soap and water washing at intervals; colour presents no problem. Damaged panels, too, like broken window panes, can be easily and inexpensively replaced. There is also the flexibility that this construction form gives in the face of plant redesign and expansion.

The major part of his lecture will be devoted to detailed case histories of six buildings: Bloor Building, Toronto; National Bank of Detroit; Gateway No. 4 Building, Pittsburg; White Castle General Office Building, Columbus; Union Carbide Building, New York; and Pottstown Hospital, Pottstown.

There have been difficulties in making these wall claddings adequate to meet the vagaries of the weather and air pollution, and to give them good insulation and fire resistant properties, but Mr. Danforth claims they are now overcome. In respect of these last properties, four US national codes have recently been re-written to embrace curtain wall construction and most major cities have or are re-writing their by-laws.

Providing Economic Services for Hospitals

Hospital design and construction is to be investigated by the Building Research Station and a programme of research is now being arranged with the Ministry of Health and the Department of Health for Scotland. This is announced in the Annual Report of the Station just published (*Building Research 1959*, published for the Department of Scientific and Industrial Research by HMSO, price 7*s*, plus 6*d* postage).

Government expenditure on hospitals is expected to increase substantially—it may amount to £300 million over the next six or seven years—and there is much scope for rewarding research in this field. For example, the cost of engineering services in hospitals (heating and ventilation, operating theatre services and lighting) can amount to a third of the total building cost. Ways of providing these services more economically will be studied by the Station. Cost studies will also be carried out on recently constructed hospitals in an effort to identify other parts of the building process where economies might be achieved. It is hoped that it will be possible to pick out anomalies in building costs between different hospitals of similar capacity and to trace the causes for the differences.

Engineering services are important not only in hospitals. In most large buildings engineering installations have become increasingly complex and expensive. Their integration with the building design and in the process of construction frequently cause dislocation and delay. The Station is investigating these problems also.

For example, to be effective barriers to sound, walls and floors should be as massive as possible but with recent advances in structural design, sound insulation now requires much additional and otherwise useless weight in partitions in flats, schools, hospitals and offices. As a continuation of field work, two specially designed experimental buildings, one brick and one frame, are now coming into use at the Station. Each comprises two floors with four rooms in each, providing four party walls and four party floors. A series of wall and floor constructions will be tried, starting with an investigation of various materials for the resilient layers of floating floors.

To help local authorities in their decisions on space and water heating systems in multi-storey flats, the Station has made a study of the efficiency of different methods. Four types of system were examined: individual solid-fuel appliances, electric floor-heating with radiant fire topping up, individual gas heating, and central heating. A report now being prepared for publication will give data on capital, maintenance and fuel costs, as well as the results of a survey on the occupants' opinions of the systems.

The use of flat roofs seems to be increasing bringing with it a problem of moisture movement inside the roof structure when the outside temperature changes. Water vapour cannot escape easily through a flat roof and condensation frequently occurs. The Station has began experiments on the thermal properties of six different types of flat roof in a pilot-scale roof laboratory that has been built there.

Soviet Plans Depend on Quality Control

In terms of quantity Soviet engineers usually meet their targets; but quality is another matter. Low standards of work represent a serious threat to Soviet expansion plans, and more attention is being paid to quality control.

By O. Tedder

RUSSIAN successes in space research, the design of guided missiles and jet airliners, and automation, seem to suggest that the quality of work in the Soviet Union is very high.

This view is not, however, shared by the Russians themselves; on the contrary, the leaders of the Soviet economy are deeply concerned by the low standard of work in industry which constitutes a serious threat to all their expansion plans. They fully realise that the short service life of Russian industrial equipment and consumer goods, their high maintenance and repair costs, the high fuel consumption of machines, etc., means that the real value of the output of Soviet industry is far below the value suggested by the figures published in output statistics. No doubt Russian visitors to the forthcoming International Conference of European Organisations for Quality Control will be following the proceedings with special interest.

Large-scale propaganda calling for an improvement of the quality of work is an indication of this concern. Such propaganda appears in almost every periodical and is repeated at all meetings which are in any way concerned with production: from humble staff meetings in factories to party conferences. The popular press stresses the need for improving the quality of products in more general terms, while in the technical press the criticisms are more specific and supported by facts and figures.

The short service life of equipment is probably the most frequent objection and it is undoubtedly the most harmful effect of bad quality work on the country's economy; but complaints about high fuel consumption, the undue heaviness of machinery and its ugly design are also very frequent.

In 1956 and 1957 a large number of foreign tractors were tested in various parts of the Soviet Union alongside the latest Soviet designs. The general conclusion drawn from these tests was that foreign machines are more economical in operation and much lighter (i.e. cheaper) than the Russian models. The service life of many vital parts of Russian tractors is quite inadequate. Thus, the track of the Rowless tractor had to be replaced after 2,200 hr of operation while the normal figure for the latest Soviet tractor, DT-54, is only 750 to 850 hr.

HAZARDS OF LUBRICATION

On the same occasion, it was found that foreign fuel oils and lubricants are much superior to corresponding Russian grades. The cleaning deoxidation, anticorrosion, viscosity, and other properties of foreign lubricants and greases were found to be better than those of Russian lubricating oils and also extended over a much wider temperature range. The impurities contained in Soviet motor fuels and the absence of any improving additives cause heavy wear to cylinders and moving parts; they increase fuel consumption and have a deteriorating effect upon the operational qualities of machines.

One of the fields of engineering in which the Russians are well advanced is automation. They were the first to put into operation a fully automatic factory. But, here too, the designers demand that the service life of Russian electrical and hydraulic automation equipment should be increased six to seven times.

As is generally known, the situation is much worse in the consumer goods industry. The director of a British advertising firm gave an exact assessment of the quality of Russian consumer goods when he said that only top quality Russian goods can be compared with the average department-store quality of the Western countries, while there is nothing in the West that is so bad as average Russian consumer goods. Indeed, it is extremely unlikely that a Western manufacturer would deliver to his customers bicycles with a service life of just over a year as do his Russian counterparts or, as in the case of a Leningrad factory, make shirts whose collars showed holes after three days' wear "because the customers fail to shave themselves properly", as the director explained.

In contrast, the work of Soviet scientists is of a very high standard and Russian designers often show in their work original ideas and new approaches to difficult problems. But Russian scientists and top designers live and work in artificially created green-house conditions, and incentives in their work are much the same as those of their Western colleagues.

The large percentage of rejects in production, the considerable amount of extra work involved in processing sub-standard raw materials and in putting new machinery to work, etc., increase production costs and in many cases mean reduced efficiency. An electric motor, for example, whose rotor needs machining by the purchaser before it can rotate in the space provided will presumably never operate at its rated power and efficiency. The same applies to a new lorry or tractor which must be towed from the distributor to the purchaser's workshop for the adjustments, alterations and even repairs necessary to start it.

In order to provide for low or unreliable quality raw materials, the defects of production and the rough handling of machines in service, Russian designers tend to make machine components larger than would normally be required. This practice improves the reliability of the equipment but increases the weight of machinery unnecessarily, which in turn adds to the price and, in the majority of cases, also results in reduced efficiency.

There is no single cause of the low standard of work in Soviet industry. The report of an engineer who investigated the causes of the frequent failures of new high-output high pressure steam boilers is typical of the situation. He said that these failures can be eliminated by a joint effort of the suppliers of semi-finished products, the manufacturers, the assembly, design, testing and research organisations and the staff of power stations.

In this connection, it is interesting to note that these failures are usually drastically reduced after about two years of service, by the power stations' maintenance staff, i.e. the only people involved who are directly interested in the trouble-free operation of the boilers.

On considering the causes of the low-quality work in Soviet industry in more detail, we find that much of it is due to the poor quality and bad condition of production equipment. This is often caused by rough treatment and inadequate replacement, and sometimes, for example in the case of oil refineries, by unsatisfactory design.

The shortage of some raw materials is also a major source of defective work. Timber and cement are frequently used where steel would be a better choice while steel is used in place of non-ferrous metals. This is done not only because better materials are scarce but more often because of the extreme complexity of the supply organisation.

Sometimes new equipment produces sub-standard work when it is installed in new factories run by insufficiently skilled staff who do not have a long tradition and experience behind them. Surprisingly enough, after more than forty years, there is still a marked difference in the quality of work of the factories built after the revolution and the works whose foundation dates back to Czarist times.

The "never-mind" and "couldn't care less" attitude which is a typical feature of the otherwise hard-working Russian, cannot be completely checked by the Soviet economic system and also bears its share of responsibility for the present poor quality of industrial products.

The basic causes of the low standard of Soviet industrial production, viz. the absence of both effective incentives and a forceful need, are rooted deep in the Soviet economic system itself, and cannot be removed without radically changing the whole system.

In the capitalist economy, the standards of quality are fixed by competition and apply in general to the whole world. Car manufacturers in Detroit, Coventry, and Paris; coffee planters in Brazil and Uganda; cotton growers in the USA, Egypt and India must all see that their products satisfy certain requirements of quality and if they fail to do so they are invariably eliminated without mercy. For a Western producer, therefore, quality and good value for money are a matter of success or failure.

TARGET PHILOSOPHY

On the other side of the Iron Curtain the main objective of the leader of an industrial enterprise is quite different: it is simply the production target, the quantity. The fulfilment of his production plan (together with good relations with his superior authorities in the industry and party) are for him the way to promotion and success. In his endeavour to achieve the fulfilment of the output plan he goes to the lowest limits, and often beyond the limits, permissible in quality, production costs, working conditions, and so on.

In these circumstances, in order to avoid an economic collapse, severe measures to protect the quality had to be taken in the early years of the Soviet state. The most important among these are the standard specifications, which in the Soviet Union have the force of law, and the contracts between purchaser and supplier, which are also backed by law.

Because at one time there was hardly a director of a Russian factory or a head of his inspection department who had not been in prison, the law, in the role of guardian of quality, did not prove very effective. Experience taught the Soviet executives that it is not very advantageous for the future to put one's business partner into prison. In addition, the manufacturers discovered that, with the exception of the generally disregarded consumer, no one in the Soviet economy is directly interested in the quality of products.

Another typically Soviet measure for improving and maintaining quality is the so-called "Socialist Competition." Here individual workers, gangs or factory departments, compete in reducing rejects or increasing the percentage of first-quality products in their output. The winners are awarded a red challenge flag, or the title of "high-quality gang" or some other prize of this kind.

Do these measures help? They certainly do, otherwise they would have been dropped long ago. But the low quality of Soviet industrial products as we see it today already includes the effect of these measures, so leaving little room for improvement. And judging from earlier experience it appears highly doubtful that any further measures capable of radically improving the quality situation can be found so long as the major economic driving forces—competition and private initiative—remain unused.

Blowing Bubbles

IF VAPOUR trails in the sky are the everyday analogy to cloud chambers, an uncorked bottle of pop will serve a similar purpose for bubble chambers. Discovered only eight years ago by D. A. Glaser, the bubble chamber has since become the most important instrument of high-energy physics.

Cloud Chambers, Emulsions and Bubble Chambers

Cloud chambers were brought to a high degree of refinement in the immediate post-war years, but could not meet the requirements imposed by the increasing particle energy and rapid pulsing rate of modern accelerators. In order to increase the probability of an interesting nuclear event taking place inside the chamber, a new recording medium was needed with much higher density than available in a low pressure vapour. Stacks of plates coated with photographic emulsions were the first answer to the problem. Such a stack can be exposed to particle beams for a long period so that there is a good chance of recording an event of significance, but the analysis of the plates is extremely tedious. Owing to the fine photographic grain-size the tracks must be viewed in a microscope, and each event must be followed through several plates. But emulsion stacks are simple and continuously sensitive, and are suitable for cosmic-ray research with high altitude balloons or earth satellites. Because of the need for lengthy analysis by trained personnel, the plates from an exposed stack are usually distributed to a large number of universities in order to share the task. The bubble chamber on the other hand is fast and lends itself to automatic data processing, and hence will be used preferentially with the large accelerators coming into service this year. Table I lists the more important current bubble chamber projects.

Chambers Clean and Dirty

Both forms of track chamber—cloud or bubble—rely on the radiation sensitivity of phase change in a metastable fluid. The track in a cloud chamber is composed of liquid droplets precipitated as a result of ionisation in a supersaturated vapour; in a bubble chamber vapour bubbles are formed in a superheated liquid. To produce a superheated condition it is necessary to decompress momentarily a liquid that is at equilibrium near its saturation temperature. The first bubble chambers were called "clean" because it was discovered that only by keeping the chamber walls rounded, smooth, free of cracks or projections, and extremely clean could spurious bubble formation be avoided. The task then was to design a usable "dirty" chamber with flat windows, gaskets, immersed light sources and reflectors in which spurious bubbling did not obscure the particle tracks. Fortunately it was found that bubble formation at the walls of the chamber tended to recompress the liquid to a certain extent and most of the volume remained sensitive to radiation; it was only important to design the chamber in such a way that bubbling would not interfere with the recording cameras' line of sight.

Short Lifetime

The sequence of operation in a bubble chamber is illustrated in Fig. 1, and Fig. 2 shows the diagrammatic arrangement of a 72 in hydrogen bubble chamber. Decompression is synchronised with the accelerator pulse, which is timed to reach the chamber towards the end of expansion. At point B bubble formation along the chamber walls slows down the rate of expansion and then compresses the liquid to point C, when the mechanism takes over and restores the initial conditions. The whole operation is very fast, a typical cycle taking around 30 milliseconds. The expansion stroke and beam impact must be carefully synchronised because the lifetime of bubble nuclei left in the wake of a particle in a *saturated* liquid is only of the order of 10^{-10} seconds. The short lifetime has the advantage that tracks from background radiation are virtually eliminated on the photographs; but at the same time it renders the chamber in its present from unsuitable for cosmic-ray research. Since cosmic rays strike a target at random, it would be desirable to trigger the chamber by the incident ray itself, but this is clearly impossible if the expansion stroke takes longer than the time during which bubble nuclei survive in the saturated liquid.

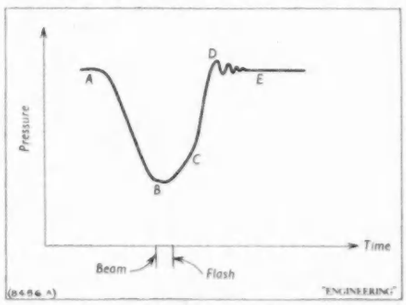


Fig. 1 A typical bubble chamber pressure-time graph showing the effects of bubble formation.

Liquid versus Vapour Expansion

As originally conceived, the mechanism of expansion and compression was to be accomplished by a piston. The system, operated by high-pressure air, is used in a number of installations and is currently in favour at CERN, where a large bubble-chamber programme was initiated in 1956. The need to drain the liquid from the chamber in order to carry out maintenance work on the piston is a considerable nuisance in case of such dangerous materials as liquid hydrogen or deuterium. The alternative is illustrated in Fig. 2 where vapour is allowed to expand through a three-way valve into a chamber, whence it is returned to the system through a compressor and refrigerator circuit. An advantage of the vapour expansion cycle is that the cooling load on the bubble chamber itself is reduced by the amount of work done by the piston in each stroke. At CERN work is now in progress on an alternative technique using ultrasonic expansion.

Liquids for Bubble Chambers

The choice of operating liquid for bubble chambers is largely determined by the type of experiment that is to be performed and the operating conditions that will be used. Owing to the simplicity of the hydrogen nucleus it is the preferred liquid for most experiments not involving interactions with neutrons. The simplest neutron bearing liquid is deuterium, but both liquid hydrogen and liquid deuterium are dangerous and expensive materials to handle. Organic liquids such as propane have the advantage of operating at room temperature instead of in the vicinity of absolute zero, but the nuclear interactions are more difficult to analyse. Helium is sometimes used because it is the lightest element with zero isotopic spin; the chamber may be operated at atmospheric pressure; and the vapour is non-poisonous or inflammable. Heavy liquids, where the mean free path is short, are used to increase the probability of certain interactions occurring inside the chamber. Xenon, mixtures of tungsten hexafluoride or methyl iodide and propane, and the compounds CF_3Br and CF_2Br_2 have been used to advantage. (D. V. Bugg: "The Bubble Chamber," *Progress in Nuclear Physics*, vol. 7.)

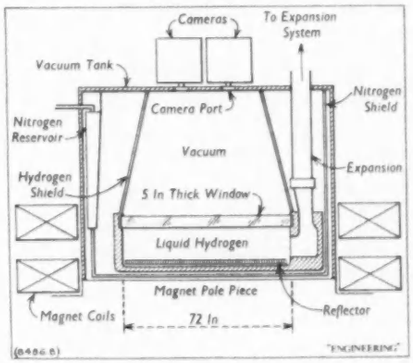


Fig. 2 A 72 in bubble chamber with two cameras.

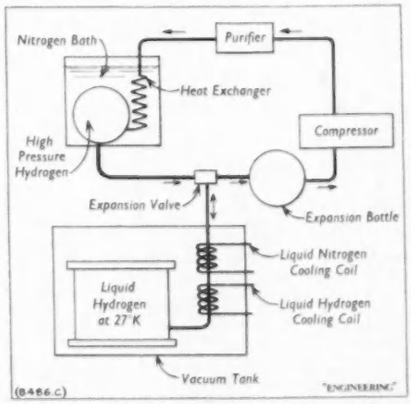


Fig. 3 Vapour expansion is a convenient alternative to the mechanical piston.

Tracks in a liquid hydrogen bubble chamber.

Experiments and Data

By means of stereophotography using two or more cameras the coordinates of the tracks left in the liquid by charged particles can be determined at suitable intervals, permitting the reconstruction of the nuclear event if something is known about the nature of the nuclei present in the liquid, and the decay modes of the unstable particles. The various possible decay modes are shown in Table II. In a magnetic field the particle path will be curved, and the curvature is a measure of the ratio of particle momentum to charge, while the direction of the curvature indicates the sign of the charge. The particle velocity and the magnitude of the charge determine the bubble density in the track, and if the mass is known, the distance in which the particle is stopped is a measure of momentum. To obtain the mass, the change in particle path curvature must be measured rather accurately, or in heavy liquid the Coulomb scattering can be used to determine the kinetic energy, and hence the product of momentum and velocity.

Track Reading Engines

The major bottleneck in the utilisation of the expensive machines of high-energy physics is the analysis of data. As most interactions are of a statistical nature it is desirable to investigate a large

Table I.—Some Notable Bubble Chambers

	Nominal size	Working liquid
Berkeley	4 in	Hydrogen
	10 in	Hydrogen
	15 in	Hydrogen
	72 in	Hydrogen
	30 in	Propane
Birmingham	9 in	Hydrogen
British National	59 in	Hydrogen
Brookhaven	20 in	Hydrogen
	80 in	Hydrogen
Caltech	2 in	Tungsten hexafluoride
	12 in	Tungsten hexafluoride
CERN	4 in	Hydrogen
	12 in	Hydrogen
	80 in.	Hydrogen
	40 in	Propane
Columbia	12 in	Propane
Dubna	4 in	Hydrogen
	17 in	Hydrogen
	63 in	Hydrogen
Duke University	4 in	Helium
	8 in	Helium
Liverpool	6 in	Propane
Michigan	12 in	Xenon
MIT	15 in	Propane methyl iodide

TABLE II.—*Decay Modes of Unstable Particles*

Particle	Decay Products	Relative Frequency (per cent)	Total Available Kinetic Energy (MeV)	Decay Product Energy (MeV)
Neutron	$p + e^- + \bar{\nu}$	—	1	$0 < E_e < 1$
Muon	$e + \nu + \bar{\nu}$	—	105	$0 < E_e < 53$
Pion (π^0)	2γ	—	133	$E_\gamma = 67$
Pion ($\pi\pm$)	$\mu + \nu$	—	33	$E_\mu = 4{\cdot}0$
Λ-hyperon	$p + \pi^-$ $n + \pi^0$	68 32	37 37	$E_p = 5$ $E_\pi = 32$
Σ^+ hyperon	$p + \pi^0$ $n + \pi^+$	67 33	116 110	$E_p = 18$ $E_{\pi^+} = 97$
Σ^0 hyperon	$\Lambda^0 + \gamma$	—	77	$E_\gamma = 72$
Σ^- hyperon	$n + \pi^-$	—	120	$E_{\pi^-} = 100$
Ξ-hyperon	$\Lambda^0 + \pi^-$	—	66	$E_{\pi^-} = 59$
Ξ-hyperon	$\Lambda^0 + \pi^0$	—	~ 70	$E_{\pi^0} \sim 60$
K± meson	$\pi\pm + \pi^+ + \pi^-$ $\pi\pm + \pi^0 + \pi^0$ $\pi\pm + \pi^0$ $\mu\pm + \nu$ $\mu\pm + \pi^0 + \nu$ $e\pm + \pi^0 + \nu$	6 2 56 27 4 5	75 86 218 387 254 358	$E_\pi < 48$ $E_\pi < 53$ $E_\pi = 108$ $E_\mu = 254$ $E_\mu < 134$ $E_e < 228$
K^0_1 meson	$\pi^+ + \pi^-$ $\pi^0 + \pi^0$	39 7	214 224	$E_\pi = 107$ $E_\pi = 112$
K_e^3 meson	$3\pi^0$ $\pi^+ + \pi^- + \pi^0$ $\pi\pm + \mu\pm + \nu$ $\pi\pm + e\pm + \nu$	11 5 21 17	89 79 248 353	$E_{\pi_0} < 57$ $E_{\pi\pm} < 50$ $E_{\pi\pm} < 116$; $E_{\mu\pm} < 133$ $E_{\pi\pm} < 127$; $E_{e\pm} < 226$

number of events, and the very high pulse-rate of accelerators—in the range of 20 pulses per minute—may produce enough interesting pictures in 24 hours of operation to keep a trained physicist busy for the rest of the year using manual methods. Automatic track recording and data processing machines are now being developed which measure the coordinates of the track and feed this data to a computer for analysis. At CERN a machine called IEP (for Instrument for Electronic Processing) is now in prototype form, while a group under J. V. Franck at the University of California have developed a similar machine called Franckenstein. Both rely on the ability of high-speed computers to derive from Cartesian coordinates the relevant bits of information needed for the analysis of the interaction. But even with automatic tracking devices the processing of films must be very carefully planned on a production basis, with frequent visual and automatic checks, before the results can be presented in concentrated form. With Franckenstein, an experienced operator can record all the relevant data from a normal event in 5 minutes, and the computer time will be only 2 to 5 minutes, but the study of the computer output needed to determine the nature of the event recorded requires 10 to 30 minutes. (H. Bradner and F. Solmitz: "On the Analysis of Bubble Chamber Tracks," Geneva paper P-730.)

Notes and News

Ducting for Gas-Cooled Reactors

The heat from current commercial atomic reactors is extracted by carbon-dioxide gas, which is then conducted to heat exchangers in ducts up to 6 ft in diameter. Owing to an increase in temperature when the reactor is operating, these ducts lengthen by possibly as much as 6 in. Since both heat exchangers and reactors must be stationary, this change in length must somehow be accommodated. In the first four atomic power stations it was taken up by bellows; but such bellows cost £2,000 to £5,000 each and up to 100 are needed at each station. In earlier work the British Welding Research Association had studied the flexibility of mitre bends when investigating general design problems of welded pipelines. On the basis of their results, it has been suggested that the bellows can be replaced by fabricated bends, at a saving of about £100,000 for each 500 MW reactor. Three of the atomic power consortia are said to be considering the proposal. (*Research for Industry, 1959*, Department of Scientific and Industrial Research, HMSO, 1960, 8*s*. 0*d*. net.)

Operation Course with Jason

Courses of two categories can be arranged by the Hawker Siddeley Nuclear Power Company on their reactor, "Jason." The first is a basic course giving the student an opportunity of working at the control console of an operating reactor and taking part in the day to day procedures under supervision. The cost of this course is £5 5*s* per day and the duration can be arranged to suit the participants. The second is an advanced course allowing the student to carry out particular experiments with the reactor giving a closer understanding of the reactor's characteristics. The operation of the controls will be carried out under supervision and participation in routine maintenance checks will also be permitted. The total duration is optional but a period of three to five weeks is recommended to obtain a thorough working knowledge of the reactor at a charge of £15 15*s* per day.

Atomic Energy Expenditure

Below is a table of the per capita expenditure on atomic energy in the principal Western countries in 1959, published by *Soldat und Technik*, August, 1960. The United States spend 79 per cent more per capita than the next country—the United Kingdom. No figures are available for countries in the East.

Country	Expenditure per capita (shillings)
United States	86·5
United Kingdom	48·2
Sweden	33·0
France	32·6
Canada	15·4
West Germany	8·5
Jugoslavia	6·5
Switzerland	5·5
Italy	3·4

Reports Received: Physics

High Temperature Resonance Integral: Using a Ferranti Mercury computer, the resonance integral for the fertile materials uranium 238, thorium 232 and plutonium 240 has been calculated with the inclusion of the effects of dilution, temperature and heterogeneity. The results closely agree with previous Monte Carlo calculations. (J. P. H. Blake: "Resonance Integral Calculations for High Temperature Reactors," AEEW—R 25.)

Cylindrical Cell Errors: Serious errors in fine-structure calculations arise through the use of the cylindrical cell approximation. The approximation gives a high moderator-to-fuel flux ratio whereas the ratio should tend to unity. (D. A. Newmarch: "Errors Due to the Cylindrical Cell Approximation in Lattice Calculations," AEEW—R 34.)

LIDO's Flux in Water and Graphite: The LIDO reactor is a light-water moderated facility used for shielding experiments. A detailed survey of thermal, epithermal, and fast neutron flux is made available to users of the reactor. (E. D. Jones: "Neutron Flux Measurements on an Aluminium Panel, in the Pool, and in a Natural Uranium Graphite Stack on LIDO," AEEW—M 608.)

Beam-Hole Flux in LIDO: Foil-activation techniques and cadmium-ratio determination have been used to measure the thermal, epithermal and fast neutron flux in the No. 2 beam-hole of the LIDO reactor using various core loadings and reflector configurations. For the same reactor power, an improved core loading increased the flux by a factor of two. (J. M. Ponce de Leon and C. J. Kenward: "Neutron Flux Measurement in the Beam Hole on LIDO," AERE—M 578.)

Slagging for Fuel Reprocessing

Oxide or halide slagging is a process whereby fission products forming more stable oxides or chlorides than the fissile elements can be removed from irradiated fuel. The process is suitable for the treatment of plutonium fuels where extreme decontamination is not required because of the high neutron energies encountered. Oxide slagging occurs at 1,400° C, and complete cerium removal requires a treatment of 8·3 hours. Plutonium recovery is poor. With chloride slagging at a temperature of 700° C, one hour of treatment completely removes lanthanum and cerium, and the plutonium recovery is 99 per cent. (L. J. Mullins, J. A. Leary and W. J. Maraman: "Removal of Fission Product Elements by Slagging," *Industrial and Engineering Chemistry*, vol 52, No. 3, pp. 227-237, March, 1960.)

The Last Word on Thorium Spectra

Information on the spectral lines of thorium and other rare earths has been accumulated since Thalén made his first measurements in 1868. In 1955 the National Bureau of Standards in Washington initiated a programme for the accurate review of spectral lines using halide electrodeless lamps. Interferometric techniques were then used to back up and improve the measurements, and the complete data have now been published under the title *New Description of Thorium Spectra* (US Department of Commerce, National Bureau of Standards Monograph 17, June, 1960, price $0·65). The work contains "twice as many lines as have heretofore been published," which is just under 15,000 wavelengths spread over 100 pages.

Plutonium Monitor With Impact Collector

To give rapid warning of the release of plutonium to the atmosphere, a continuously sampling monitor collects dust particles on a zinc sulphide coated film that is checked for alpha radiation. The film collects particles of 1 micron size preferentially while neglecting smaller particles typical of radon and thoron decay products. Sampling is carried out for preselected periods, a typical sequence lasting ten minutes. The integral count is then recorded and if excessive, a warning circuit is energised. The instrument, a development from the Atomic Weapons Research Establishment, is to be shown at the 5th International Instruments and Measurements Exhibition, Stockholm, 10 to 17 September.

Shifting Emphasis in IAEA Programme

Reflecting the change in hopes for the early realisation of nuclear power in industrialised or underdeveloped countries, the emphasis in the programme of the International Atomic Energy Authority has been shifted from advanced projects to more preparatory work. The two most important programmes of the Agency are now technical assistance and training in nuclear techniques, instead of the international clearing of nuclear materials.

Rules for Nuclear Ships

Lloyd's Register of Shipping has published a set of provisional rules for the design, construction and maintenance of nuclear ships. The "1,000 mile" requirement for emergency power in case of single-reactor vessels is incorporated in the rules; the power output of the auxiliary machines must be sufficient to maintain a ship's speed of about 6 knots.

Reactor Notes

SELNI Receives Loan: The United States Export Import Bank has granted a loan of $34 million for the SELNI reactor project, the Bank's first entry into nuclear power station construction.

Japan's Revised Plans: The outdated Japanese nuclear power programme (Atomic Review, 25 March 1960) has been finally revised. The new plan calls for the installation of 1,000 MW(e) capacity by 1970, with an additional 5,000 MW by 1980.

THE NUCLEAR POWER GROUP

requires

DESIGN ENGINEERS

With the granting of the contract for the construction of the Dungeness Nuclear Power Station, we are now the only Group actively engaged upon the construction of four major nuclear power stations as well as future designs for the United Kingdom and overseas stations.

Applications are now invited from suitably qualified men for the following appointments.

1. SENIOR ENGINEER—to work on the design and development of burst fuel element detection systems. Experience in that field desirable, but not essential.

2. SENIOR ENGINEER—to work on the design of special reactor components, including core components, remote handling equipment and special mechanisms.

Applicants should have an Hons. degree and several years' experience in industrial design work.

The successful candidates will work in the Groups Offices situated in their own grounds at Knutsford, Cheshire.

Housing assistance will be given to married men.

Applications, giving details of age, qualifications, and experience, should be addressed to:—

The Personnel Manager,
The Nuclear Power Group,
Radbroke Hall, Knutsford, Cheshire

Quoting reference: E/ELEC/6. C 776

RADIOLOGICAL PROTECTION

Atomic Energy Research Establishment, Harwell

The HEALTH PHYSICS DIVISION carries out radiation and contamination measurements, investigates health physics problems and advises staff on aspects of radiological safety. The work is discharged by means of two Operations Groups responsible for laboratories and buildings in a particular area who operate through small teams of HEALTH SURVEYORS assisted by industrial staff. There are vacancies for a

1. **SENIOR HEALTH SURVEYOR** (Salary: £1535-£1900 p.a.) to lead a team of Health Surveyors in the above work.
2. **HEALTH SURVEYOR** (Salary: £1110-£1360 p.a.).
3. **REACTOR HEALTH PHYSICISTS** (Salary: £1110-£1360 p.a.) to provide an experimental and advisory service in connection with the operation of high and low flux reactors.

Applicants should have G.C.E. at "A" level, H.N.C. in Applied Physics or equivalent and have had several years' experience in relevant work. A degree would be an advantage. Experience of dealing with radioactivity is essential for the first post and an advantage for the others.

Send POST CARD for details to
PERSONNEL MANAGER (1748/26), U.K.A.E.A., A.E.R.E., HARWELL, DIDCOT, BERKS. C 766

WORKS MANAGER

G. & J. KITCAT LTD., PUBLISHERS' BOOKBINDERS, LONDON, propose to appoint a WORKS MANAGER who will be responsible for production. The bindery is highly mechanised, hence analogous to light engineering. It is hoped to find a man who will be ready to accept wider responsibilities in a few years' time.

Candidates must have first-class experience in works management and production planning; a knowledge of bindery machines and processes, though desirable, is not essential. The most appropriate age is between 35 and 45.

The salary will be commensurate with the qualifications required; there is a contributory pension scheme with life insurance.

Applications, which will be treated in confidence, should be addressed to

The Secretary (Bindery),
14 Welbeck Street, London, W.1 C 786

'Engineering' Appointments Section

PUBLIC APPOINTMENTS

ROYAL TECHNICAL COLLEGE, SALFORD
DEPARTMENT OF MECHANICAL ENGINEERING

Applications are invited for the appointment of a RESEARCH FELLOW in this COLLEGE OF ADVANCED TECHNOLOGY at a salary of £800-£850 p.a.

The person appointed will devote his whole time, for a minimum of two years, to research in vibration phenomena in machine tools, for which there are excellent facilities and equipment. Applicants should have good academic qualifications and research experience in mechanical vibrations or in a closely related subject. The research is supported initially for two years by a D.S.I.R. grant, but candidates will be considered from the outset for appointment to the permanent academic staff of the College. If so appointed, the successful candidate would be expected to continue the research after the initial period of two years.

Further particulars and forms of application may be obtained from the REGISTRAR, ROYAL TECHNICAL COLLEGE, SALFORD, 5, LANCS., to whom applications should be returned by 31st AUGUST, 1960. C 756

ASSISTANT SECRETARY

THE INSTITUTION OF GAS ENGINEERS invites Applications not later than 12th SEPTEMBER, 1960, for the Appointment of ASSISTANT SECRETARY at a commencing salary of £1750 per annum. Conditions from the SECRETARY, THE INSTITUTION OF GAS ENGINEERS, 17, GROSVENOR CRESCENT, LONDON, S.W.1. C 755

GOVERNMENT OF TANGANYIKA

FACTORY INSPECTOR (male, aged 32-40) required to undertake, under general direction of Labour Commissioner, administration of legislation, organisation of factory inspection, training and supervision of Inspectors. B.Sc. (Engineering) degree or equivalent (e.g. A.M.I.Mech.E.) essential. Previous experience in administration of factories legislation or in industry as a Safety Engineer, desirable. Post on contract; resettlement grant terms. Salary scale £1194 to £1863 inclusive. Quarters at low rental. Free passages and medical attendance. Education allowance (in respect of children educated in secondary schools outside Tanganyika). Tour of service 30-36 months. Low income tax. Generous home leave.—Further particulars and application forms from DIRECTOR OF RECRUITMENT, COLONIAL OFFICE, LONDON, S.W.1, quoting BCD.132/8/01/D5. Candidates should state their full names when applying. C 765

CLYDE NAVIGATION TRUST
HYDROGRAPHIC SURVEYOR

Applications are invited, from suitably qualified candidates, for the post of Hydrographic Surveyor on the staff of the Trust.

Applicants must have experience in taking soundings by lead line and by echo sounding machine. Good draughtsmanship is essential and applicants should have the ability to plot soundings and to prepare dredging plans and estimates.

Applicants should state age, and full particulars of education, training and experience.

The commencing salary will be £995, rising to £1240 per annum. The successful applicant will be required to pass a medical examination and become a member of the Trustees' Superannuation Fund.

Applications, which will be treated in strictest confidence, should be lodged with the ENGINEER, CLYDE NAVIGATION TRUST, 16 ROBERTSON STREET, GLASGOW, C.2.

C 699

TYNE IMPROVEMENT COMMISSION
APPOINTMENT OF ASSISTANT ELECTRICAL ENGINEER

Applications are invited for the position of ASSISTANT ELECTRICAL ENGINEER, under the Commissioners' Electrical Engineer, in their Dock and Harbour Undertaking. The minimum qualification is the Higher National Certificate in Electrical Engineering and Membership of the Institution of Electrical Engineers with at least Student or Graduate status.

Applicants should have had experience in the maintenance and operation of A.C. and D.C. operated plant, control gear, substations and distribution systems, etc.

The commencing salary will be within the range £850 to £1300 per annum according to age and experience.

The post is superannuable and the successful applicant will be required to pass a medical examination and become a member of the Tyne Commission Superannuation Fund.

Applications stating age, qualifications and experience and giving the names of referees who can testify to the candidate's character and professional ability, should be sent to the undersigned in envelopes endorsed "ASSISTANT ELECTRICAL ENGINEER" not later than 6th SEPTEMBER, 1960.

R. N. EGGLETON,
SECRETARY.

BEWICK STREET,
NEWCASTLE UPON TYNE, 1. C 760

DESIGNER DRAUGHTSMEN

AIR MINISTRY, Works Designs Branch, requires in LONDON, STRUCTURAL ENGINEERING DESIGNER DRAUGHTSMEN for reinforced concrete or structural steelwork of all types. Applicants must have adequate training and several years' experience. Some site experience and possession of recognised technical qualification an advantage. Financial assistance and time off may be allowed for recognised courses of study. Promotion and pension prospects. Five-day week with 18 days paid leave per year initially. Salary ranges from £680 (at age 25) to £900 p.a. Commencing salary dependent on age, quals. and exp. Applicants, who must be natural born British subjects, should write to AIR MINISTRY, W.G.d., LACON HOUSE, THEOBALDS ROAD, LONDON, W.C.1, or apply to any Employment Exchange quoting Kings Cross 3745, giving age, details of training, quals., full particulars of former posts held and copies of any testimonials. Candidates selected will normally be interviewed in London and certain expenses reimbursed. G 888

WOLVERHAMPTON CORPORATION
WATER UNDERTAKING

requires two ENGINEERING ASSISTANTS for new works design and construction. Salary according to qualifications and experience, £1065-£1220 (Grade APT IV) or £785-£1070 (Special Grade). N.J.C. Service Conditions, 5 day week, house to rent. Post pensionable, medical examination.—Applications, naming two referees, to WATER ENGINEER AND MANAGER, WATER OFFICES, 37 MERRIDALE ROAD, WOLVERHAMPTON, by AUGUST 29th, 1960. C 738

DEPUTY PRINCIPAL

The COAL UTILISATION COUNCIL is expanding yet again to cope with the many opportunities in the market for domestic solid fuel. We are a friendly and active non-commercial organisation. Hours are 9.30 to 5.30, Monday to Friday; 18 days' holiday a year. Optional pension fund.

One of the people we are looking for, and the minimum commencing salary we have in mind is:—

DEPUTY PRINCIPAL of the Council's Training Centre at Vauxhall, with good educational background, preferably in Science or Mechanical Engineering. He will be responsible for the daily supervision and administration of training courses. A good knowledge of domestic heating practice and ability to write technical reports important. Lecturing experience and organising ability essential. £1,200.

Apply to C.U.C., 3, UPPER BELGRAVE STREET, S.W.1 (SLOane 9116) for an application form and fuller particulars. C 782

MARTECH

CONSULTANTS LIMITED

have been retained to advise on two appointments for an engineering company in the north of England whose products in the pumping and industrial transmission field are used through a wide range of industry. The company is a family concern, with an exceptionally pleasant working atmosphere, and runs a non-contributory pension scheme. About 300 people are employed including a field sales force of 12 representatives. Conditions are favourable for a considerable expansion of turnover and the requirements are:

SALES MANAGER

to take control of the sales force, be responsible for sales development, and contribute to product policy.

Experience of sales management and control of a sales force in a similar field is essential. Applicants should already be earning approximately the starting salary offered of £2,500-£3,000. Preferred age 35-45. An engineering qualification is desirable.

It is essential that the new man should fit in and quickly merit a position on the Board.

WORKS MANAGER

to take full responsibility for production at a modern and spacious factory which allows room for expansion. A basic training in a similar engineering field is essential and a formal qualification is desirable. Applicants should have had experience of works management, preferably involving large batch production. Preferred age 30-35. Starting salary £1,750-£2,000.

This is an opportunity with excellent prospects for a man of proved ability.

Applications will be treated in strict confidence and no information passed on without the candidate's permission. Please write to:

WARREN LAMB,
69 Grosvenor Street,
London, W.1.

C 768

PERSONNEL ADMINISTRATION LIMITED

MANAGEMENT CONSULTANTS

Our Appointments Division has been asked to advise on the following post:

PRODUCTION ENGINEER

LONDON

A large British organisation providing a vital service to a major industry has decided to create a Production Engineering Division. The Divisional Manager will be required to devise and implement his own programme of projects covering process layout, methods, machinery, material flow and work measurement (not incentives). This will involve building a team of specialists who will operate in all parts of the country. Candidates should be graduates or professional engineers between 35 and 45 with wide production engineering experience preferably in large-scale industries such as automobiles, aircraft or shipbuilding. Management Consultants are particularly welcome. Salary up to £3000; pension. Although this is a permanent post the experience would probably lead to one of the top posts in the industry. (Ref. 1451/EN.)

The identity of candidates will not be revealed to our clients without their prior permission. For the convenience of clients and candidates we have Regional Offices in ***Glasgow, Manchester, Bristol*** *and* ***Birmingham*** *but in the first instance, applicants should forward brief details, quoting the reference number, to:—*

PERSONNEL ADMINISTRATION LIMITED

APPOINTMENTS DIVISION, 2 ALBERT GATE, LONDON, S.W.1

C 751

Unilever | CEYLON

ASSISTANT ENGINEER
COLOMBO

Ceylonese nationals, who are qualified mechanical or electrical engineers, are invited to apply for the post of Assistant Engineer in Unilever's company in Ceylon.

Candidates should be under 30.

The man selected will be able to look forward to a progressive management career, and starting salary will be in line with the opportunities offered. Initial training will be given in this country.

Applications should be addressed to:

PERSONNEL DIVISION (T 322)
UNILEVER HOUSE, BLACKFRIARS, LONDON, E.C.4

C 764

ENGINEERING CLERKS OF WORKS

MANCHESTER REGIONAL HOSPITAL BOARD invite applications for three posts of ENGINEERING CLERKS OF WORKS (ELECTRICAL) AND MECHANICAL) in connection with the hospital capital building programme. Salary £600 by £40(5) by £50(1) to £1050. National Health Service conditions and superannuation. Application forms obtainable from the SECRETARY OF THE BOARD, CHEETWOOD ROAD, MANCHESTER, 8, to whom they should be returned by 6th SEPTEMBER, 1960. C 780

CITY OF NOTTINGHAM
WATER DEPARTMENT
APPOINTMENT OF TWO GRADE APT V CIVIL ENGINEERING ASSISTANTS

Applications for the above permanent, pensionable appointments are invited from Engineering Graduates, and/or Corporate Members of the Institution of Civil Engineers with five years' engineering experience, preferably with a Water Undertaking. The Department has in hand a varied programme of new works estimated to cost £1½ millions, offering considerable opportunities for gaining valuable experience. Salary, dependent upon qualifications and experience, £1220 by £55 by £50's (2) = £1375.

Applications, with names of two persons to whom reference may be made, to ENGINEER AND GENERAL MANAGER, WATER DEPARTMENT, CASTLE BOULEVARD, NOTTINGHAM, not later than 31st AUGUST, 1960

T. J. OWEN,
TOWN CLERK.

THE GUILDHALL,
NOTTINGHAM.

C 778

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

AIR MINISTRY require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary: £805 at 25 to £1095 at 34 or over, thereafter rising to max. £1260 with increase for London and slight decrease for country districts. Appointments non-pensionable but long term. Promotion prospects. Five-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service. Qualifications and experience:

(i) (*a*) University degree or equiv. diploma in electrical and/or mechanical engineering with at least 2 years' apprenticeship; or
(*b*) Graduate or corporate member of I.E.E. with at least 3 years' apprenticeship; or
(*c*) Graduate or corporate member of I.Mech.E. appreciable electrical engineering experience with at least 3 years' apprenticeship; and
(ii) Have been employed for minimum of 2 years with well established engineering concern and gained wide experience in both electrica and mechanical engineering practice.

Applicants must be natural born British subjects between ages of 25 and 45.

Forms from MINISTRY OF LABOUR, TECHNICAL AND SCIENTIFIC REGISTER (K), 26, KING STREET, LONDON, S.W.1, quoting D.158/OA. C 771

APPOINTMENTS OPEN

TECHNICAL AUTHOR

TECHNICAL AUTHOR required, not over 45, to assume responsibility for the compilation of operating and maintenance instruction manuals dealing with the Company's machinery. This interesting and progressive pensionable staff position would appeal to a suitably qualified Mechanical Engineer with a bias towards technical writing.—Applications should be addressed to the PERSONNEL MANAGER, MOLINS MACHINE CO., LTD., EVELYN STREET, LONDON, S.E.8. C 69 :

DRAUGHTSMEN

DRAUGHTSMEN required for expansion programme by old established Yorkshire Company and preferably having specialised experience in one or more of the following subjects:—transmission, hydraulics, electric motors, switchgear. These are permanent positions in modern offices with a progressive Company.

Applications should state age, experience, technical qualifications and salary expected. Write BOX E.493, c/o STREETS, 110, OLD BROAD STREET, E.C.2. C 742

DRAUGHTSMAN DESIGNER

DRAUGHTSMAN DESIGNER required for Equipment Department (responsible for new layouts, etc., in various parts of Fort Dunlop factory). The work covers mechanical handling and/or design of automatic and semi-automatic machinery for rubber processing and tyre manufacture. (Rubber experience not essential but applicants should know something about mechanical handling and/or special-purpose machine design in other industries). Holiday arrangements respected. Pension scheme; five-day week; excellent working conditions. Age range: 25-45.—Please write, giving brief details and commencing salary required, to STAFF OFFICER (REFERENCE E), EMPLOYMENT DEPARTMENT, FORT DUNLOP, ERDINGTON, BIRMINGHAM, 24. C 753

THE DISTILLERS COMPANY LIMITED

MECHANICAL ENGINEER (STANDARDS)

The Company has the above vacancy in its Engineering Division at Devonshire House in the West End of London. Candidates will be required to prepare engineering standards for chemical and other process industries, and should therefore have had experience in such work. Preference will be given to candidates who are Associate Members of the Institute of Mechanical Engineers. Age range 25-40. Working conditions are excellent, and the Company runs a non-contributory pension scheme and other fringe benefits.

Write:
STAFF MANAGER
THE DISTILLERS COMPANY LIMITED
21-22 BOLTON STREET
LONDON, W.1.

Quote Ref. 83/60 E. C 743

DEVELOPMENT ENGINEER

DEVELOPMENT ENGINEER for GASKET MANUFACTURERS, SLOUGH, to be responsible for research into sealing problems, for conducting an Advisory Service to customers and for controlling the present Test Laboratory.

A technical training, including some practical foundry experience, several years' experience of automobile engine design and testing, and ability to get on with people are indispensable.

Age up to 60 will be considered, providing in good health. A good salary commensurate with responsibility will be paid.

All applications will be treated in the strictest confidence.

Write to MANAGING DIRECTOR, COOPERS MECHANICAL JOINTS LIMITED, LIVERPOOL ROAD, SLOUGH, BUCKS. C 759

CHEMICAL OR MECHANICAL ENGINEER

THE ELECTRICAL WELDING DIVISION OF THE B.O.C. GROUP OF COMPANIES requires a CHEMICAL OR MECHANICAL ENGINEER to undertake design and development work of new manufacturing plant. Candidates should be graduates or members of a senior professional institution and should preferably have had experience of the design of modern mass production equipment or wire handling machinery.—Apply in writing to STAFF PERSONNEL OFFICER, QUASI-ARC LTD., BILSTON, STAFFS. C 758

MECHANICAL ENGINEER

Consulting engineers require MECHANICAL ENGINEER, aged 25 to 30, with H.N.C. good knowledge of English and general training and experience for varied work including heating, power and refrigeration. Non contributory pension fund.—Write with full particulars, MACKNESS & SHIPLEY, PARLIAMENT MANSIONS, ABBEY ORCHARD STREET, S.W.1. C 763

MECHANICAL ENGINEER

Burma Corporation (1951) Limited, a large Mining Company operating in Upper Burma, climate sub-tropical and healthy, has a vacancy for a Mechanical Engineer. Applicants must be suitably qualified and have had not less than 5 years' practical experience (excluding apprenticeship) in all-round mechanical engineering in a heavy industry.

Four years agreement; six months paid leave of which three months normally permitted after two years; contributory Provident Fund, free passage, partly furnished quarters and medical attention. Commencing salary and allowances aggregate K.1325 (£99 7s. 6d.) per month, rising to K.1475 (£110 12s. 6d.) in fourth year. Advise fullest details education, qualifications, experience, age and family status.

WRITE BOX T.637, W.P.S., 4, HOLBORN CIRCUS, LONDON, E.C.1. C 750

FORD MOTOR COMPANY, LIMITED

ENGINEERING RESEARCH

LODGE ROAD

BIRMINGHAM, 18

Have vacancies for TWO SENIOR DEVELOPMENT ENGINEERS in their Power Units Engineering Research Dept., to work on the Development of Advanced Projects.

Applicants should be corporate members of the Institution of Mechanical Engineers; a degree in Mechanical Engineering would be an advantage.

They must be fully capable of taking complete charge of Projects involving Design, Research and Development of all forms of internal combustion engines with experience preferably in those for Passenger and Commercial Vehicles.

Age range 30/40 years. These are positions of responsibility and carry an appropriate salary in accordance with qualification and experience.

C 749

MECHANICAL ENGINEERING

ASSISTANT

MECHANICAL ENGINEERING ASSISTANT REQUIRED for design and development work on cable-making machinery. Some electrical experience is desirable. Applicant should have had practical experience as well as theoretical training at least up to H.N.C. standard. He must be capable of following his designs through manufacture and subsequent application. The work is interesting and offers scope to an inventive mind. Age 25-35. Salary commensurate with ability and qualifications. —Apply in confidence to Personnel Officer, Southern United Telephone Cables Ltd., Dagenham, Essex.

C 730

DESIGNER DRAUGHTSMAN

DESIGNER/DRAUGHTSMAN required for small but expanding Company in SOUTH BUCKS to extend their range of Centrifugal Pumps and other projects. Candidates must have experience of pump applications including hot water circulation duties and be able to work without supervision.—Apply stating age, experience and salary required, to: BOX C 728, Offices of ENGINEERING.

DEVELOPMENT ENGINEER

DEVELOPMENT ENGINEER required for the Diesel Engineering Division of the Rootes Group with experience of high speed diesel engine development. Educational standard must be up to H.N.C. minimum and preferably higher. Applicants should be capable of dealing with all phases of diesel engine development. Apply, with full particulars and salary required, to THE SECRETARY, TILLING-STEVENS LTD. (A ROOTES GROUP COMPANY), VICTORIA WORKS, MAIDSTONE, KENT.

C 773

PROJECT ENGINEER

QUAKER OATS LTD.

We require a PROJECT ENGINEER (aged 25/35) for an important position in our Engineering Planning and Development Department.

The work covers a wide and interesting field of investigation and design necessitating close liaison with Production Departments and Specialist Suppliers.

Previous experience of development work, particularly in the Food Industry, would be an advantage.

Please write stating qualifications and details of career to:

PERSONNEL MANAGER (PE 15),
QUAKER OATS, LTD.,
BRIDGE ROAD,
SOUTHALL, MIDDLESEX.

C 772

ENGINEER

BRITISH OXYGEN RESEARCH & DEVELOPMENT LTD. have a vacancy for an ENGINEER to carry out research and development work on pumps and pumping problems at low temperatures.

Please write to THE SECRETARY, BRITISH OXYGEN RESEARCH & DEVELOPMENT LTD., DEER PARK ROAD, LONDON, S.W.19. C 775

REED BROTHERS (ENGINEERING) LTD.

SENIOR & JUNIOR DRAUGHTSMEN

required for varied and interesting design work on Medium and Heavy Hydraulic Press Projects. Experienced men preferred but applicants with good general engineering background considered. Excellent working conditions with Pension Scheme and Luncheon Vouchers. Write:

PERSONNEL MANAGER,
REPLANT WORKS,
WOOLWICH INDUSTRIAL ESTATE,
LONDON, S.E.18. C 777

MECHANICAL, ELECTRICAL AND

CIVIL ENGINEERS

MECHANICAL, ELECTRICAL AND CIVIL ENGINEERS required by North Eastern engineering office dealing with industrial power plants and electrification schemes. The applicants, who should be aged between 28 and 35 years, should be keen and able to work with minimum supervision. Minimum qualification is H.N.C. together with good experience in Thermal Plant/Electrical design layout and the ability to handle Contract work. Contributory Superannuation Scheme. Reply giving full details of age, experience and present salary to BOX C 770, Offices of ENGINEERING.

VIBRATION INVESTIGATIONS

THE BRITISH SHIPBUILDING RESEARCH ASSOCIATION requires a UNIVERSITY GRADUATE to take charge of a small section carrying out researches into ship machinery vibration problems. Previous experience in this field is essential and practical training would be an advantage. The starting salary, depending on age and qualifications, will be in the range of £1000 to £1700 per annum. The position carries superannuation under F.S.S.U. Applications with full particulars should be addressed to: B.S.R.A., 5, CHESTERFIELD GARDENS, CURZON STREET, LONDON, W.1. C 785

DRAUGHTSMEN

FISONS FERTILIZERS LIMITED need the services of EXPERIENCED DRAUGHTSMEN who preferably have spent some time working in the Chemical Industry. The persons appointed to fill these vacancies should possess O.N.C.—preferably H.N.C. as the work involved requires detailed knowledge of modern machinery. Problems affecting both design and maintenance are part of the job. Working conditions are good. Staff amenities are comprehensive. Help with housing can be given for persons willing to move to this part of the East Coast which offers attractions to lovers of both Coast and Countryside. Applications giving present position and salary, previous experience and employers, and educational qualifications, should be sent to:—WORKS MANAGER, FISONS FERTILIZERS LIMITED, IMMINGHAM, GRIMSBY, LINCS. C 783

HEALTH PHYSICISTS

are required by the UNITED KINGDOM ATOMIC ENERGY AUTHORITY in the HEALTH PHYSICS DEPARTMENT AT WINDSCALE AND CALDER WORKS, CUMBERLAND.

This department advises on all aspects of safety, including radiological and nuclear safety, for a large Works consisting of a number of nuclear reactors, laboratory facilities and large chemical plants handling radioactive materials.

The duties of successful applicants would be either:

(*a*) responsibility for the organisation and operation of a section of the Operations Control Group of the Health Physics Department. This work will involve the organisation of site monitoring teams used to measure and assess radiation and contamination conditions and to advise the plant management on safety precautions;

or (*b*) to carry out scientific and technical investigations in the Health and Safety field. The main emphasis will be on investigations into special problems associated with the site, but it is envisaged that there may be scope for more fundamental research.

Applicants must possess an Honours degree, or equivalent, in physics, chemistry or engineering. Previous experience in the field of radiological protection, while desirable, is not essential.

Salary scale £860 at age 25 to £1340 per annum. Contributory Superannuation. Staff Housing Scheme.

Send postcard for application form quoting reference P/W.40/J.2 to: RECRUITMENT OFFICER, U.K.A.E.A., PRODUCTION GROUP, WINDSCALE WORKS, SELLAFIELD, SEASCALE, CUMBERLAND.

Closing Date: 5th SEPTEMBER, 1960. C 779

DRAUGHTSMEN

required for the Diesel Engineering Division of the Rootes Group:—

(*a*) SENIOR DRAUGHTSMAN with experience of high speed diesel engines. Initiative essential for this appointment.

(*b*) DRAUGHTSMAN with experience of high speed diesel engines for design and detail work.

In both cases applicants must be up to H.N.C. standard of technical education.

Apply, with full particulars and salary required, to THE SECRETARY, TILLING-STEVENS LTD. (A ROOTES GROUP COMPANY), VICTORIA WORKS, MAIDSTONE, KENT. C 774

EUCLID (GREAT BRITAIN) LIMITED

have a vacancy for a

TECHNICAL ARTIST

Experience in technical illustration essential; experience in lay-out, lettering and re-touching desirable. The job entails design and art work of technical literature sales folders, and advertisements.

The Company operates a comprehensive personnel policy including Free Life Assurance and Contributory Pension Scheme. Canteen facilities on the Estate. All applications in writing to the

PERSONNEL DEPARTMENT,
EUCLID (GT. BRITAIN) LIMITED,
NEWHOUSE INDUSTRIAL ESTATE,
MOTHERWELL. C 744

Chief Engineer

A large oil storage installation on the Thames requires a Chief Engineer to take control of its Engineering Department.

Applicants must be of good education and have an Engineering Degree (preferably B.Sc. in Mechanical Engineering), together with long term practical experience in the handling of men, plant maintenance, budgetary control and administration.

The salary offered is attractive and applicants between the ages of 40-50 would be preferred. The company operates a contributory Pension Scheme, with Life Assurance.

Write, giving full details of education, qualifications and past experience, to:

The Managing Director,
London & Thames Haven Oil Wharves, Ltd.,
Bucklersbury House,
83, Cannon Street, London, E.C.4. C 781

ENGINEER SURVEYOR

ENGINEER SURVEYOR required for inspection of Boiler and Pressure plant. Must have 1st Class M.O.T. Certificate with Steam endorsement or equivalent. Starting salary £800, rises to £1100 (E.S.A. Scale). Other benefits. Area Chester and North Wales.—Apply ENG. DEPT., GENERAL ASSURANCE CORP. LTD., 99, ALDWYCH, W.C.2. C 720

G.W.B. FURNACES LIMITED

CONTROL GEAR DIVISION

SALES ENGINEER

required for London and the Home Counties.

He should have experience of electric motor control gear, contactors, relays, multi-motor control panels, switchboards, etc.

This is a senior appointment and a good salary is paid, plus expenses. The position is permanent and pensionable.

A company car is provided.

Write in confidence, giving details of age, qualifications and career to date, to:

SALES MANAGER,
CONTROL GEAR DIVISION,
G.W.B. Furnaces Limited,
DUDLEY,
WORCS. C 702

APC

Vacancies exist in the Central London Technical Department for

MECHANICAL ENGINEERS

to undertake theoretical investigations associated with the design, control and performance of nuclear power stations. Candidates should have a good honours degree and some industrial experience.

Applications giving full details of experience and qualifications should be sent to:

The Personnel Manager (Ref. E/131)
ATOMIC POWER CONSTRUCTIONS LTD.,
P.O. BOX 90,
28 THEOBALDS ROAD, W.C.1.

C 767

ENGINEER

ENGINEER (about 30 years) required for Consulting Engineers' Office in Manchester; Engineering degree and/or corporate membership of a major engineering Institution; varied industrial experience an advantage. Technical investigations and reports in matters where litigation is being considered. Apply BOX C 741, Offices of ENGINEERING.

NORTHERN ALUMINIUM CO. LTD.

BANBURY

Require an ENGINEER aged 26/32 to undertake design and development work in the Engineering Section of the Sales Development Division. The post, which involves a variety of interesting projects, calls for technical competence and initiative, and candidates should preferably have some knowledge of design in and fabrication of aluminium. A good engineering background and academic qualifications of university degree standard essential.

Write, giving full details of education, experience, etc. to:—

PERSONNEL OFFICER,
NORTHERN ALUMINIUM CO. LTD.
BUSH HOUSE,
ALDWYCH, LONDON, W.C.2

C 752

WORK STUDY ENGINEERS

WORK STUDY ENGINEERS are invited to apply for vacancies that offer temporary engagements, at advantageous terms of 1 to 2 years' duration, in a light Engineering factory situated in the Midlands.

The project involved is of importance and concerns review, re-study and implementation of Company Policy in the application of Work Study affecting several thousand employees.

Permanent posts will be available to some participants on completion of this project.

Applicants should write, quoting E/M, stating age, qualifications and experience, to THE PERSONNEL MANAGER, BOX C 700, Offices of ENGINEERING.

FOR ADVERTISEMENT RATES: SEE TRADE & TECHNICAL SECTION PAGE 4

COMPANY MEETING

JOHN BROWN AND COMPANY LIMITED

Engineers and Shipbuilders

INCREASED PROFITS AND STRONG LIQUID POSITION

LORD ABERCONWAY'S STATEMENT

THE 96th Annual General Meeting of John Brown and Company Limited will be held on September 2nd in London.

The following is an extract from Lord ABERCONWAY's statement circulated with the Report and Accounts for the year ended March 31, 1960:

The Consolidated Profit before tax was (to the nearest £1,000) £3,645,000, an increase of £292,000 over that of the previous year. The Consolidated Balance Sheet reveals a strong liquid position. Cash and its near equivalent stand at £8,810,000, an increase over the previous year of £3,651,000. In view of the increase in profit, and of the strong liquid position, the Directors have decided to recommend a final Ordinary dividend of 7 per cent, less tax, making a total for the year of 11 per cent, less tax, compared with 10 per cent, less tax, for the previous year.

Sir Stanley Rawson, to the great personal regret of his colleagues, retired during the year from the Board. His knowledge and experience, and his wisdom and judgment, will be much missed.

Shipbuilding

Her Majesty the Queen Mother graciously visited Clydebank on 16th September, 1959, to name and launch the 50,000 ton deadweight tanker s.s. "BRITISH QUEEN" for the B.P. Tanker Company Ltd. Earlier in the year the same owners took delivery of a 42,000 ton tanker, s.s. "BRITISH JUDGE," and m.v. "CLAN MACINDOE" was completed for the Neptune Shipping Company Ltd. The anti-submarine frigate H.M.S. "YARMOUTH" was commissioned in March, 1960, and earned high praise from all who inspected her.

Two 50,000 ton deadweight tankers are under construction and the s.s. "TRANSVAAL CASTLE" of 33,000 tons gross will be launched next January for The Union-Castle Mail Steamship Company Ltd. Good progress is being made on H.M.S. "HAMPSHIRE," a guided missile ship.

Clydebank has co-operated over a considerable period with The Cunard Steam-Ship Company Ltd. in their design studies for a new express liner, and it is gratifying that the Chandos Committee has approved the resulting design. It is, of course, our hope that Clydebank will be asked to extend its collaboration to the building of the ship.

On 30th September, 1959, Sir James McNeill relinquished his executive duties as Managing Director of John Brown & Co. (Clydebank) Ltd. He remains as Deputy Chairman of the Clydebank company, where his experience, his judgment, and his incomparable knowledge of shipbuilding will be of inestimable value, and continues of course as a director of John Brown & Company. He is succeeded, as Managing Director of the Clydebank company, by Mr. John Brown, formerly the Naval Architect.

Land Boilers

The business of supplying large boilers for power stations, in which **John Brown Land Boilers Ltd.** is engaged, has continued to be difficult. The orders remaining to be executed will shortly be very few. Indeed, the order for a boiler for Bankside station remains the only order that the company has received from a British generating authority for more than four years. The recently announced addition to the programme of new generating capacity is helpful; even so, the future of John Brown Land Boilers Ltd. is far from assured.

Machine Tools and Engineers' Tools

Wickman Ltd. during the latter half of the year experienced a very substantial increase in the demand for its multi-spindle automatics. Most of this came from makers of motor vehicles and domestic appliances, at home and overseas. More orders were received last year for automatics than ever before, and quoted deliveries, which had been reduced to some six months, are now about eighteen months. Wickman's manufacture and sales of "Wimet" tungsten carbide tools have increased considerably, and re-tooling of automatics with "Wimet" tools is becomin an increasing feature of its business.

Webster & Bennett Ltd. continued in full production during the year and achieved a record output of its vertical boring and turning mills. The rate of incoming orders has improved since this time last year, but is still much below the capacity of the factory. A moderate reduction in the production programme will therefore be necessary in the latter part of the current year; but owing to labour wastage this will involve no redundancy.

Firth Brown Tools Ltd. has benefited from the general revival in the demand for engineers' cutting tools, and has had a good year both at home and in export markets. A new research department on machinability is nearing completion; an important unit in this is a new test lathe with exceptional speed and power, with which it is intended to explore the next generation of machine tools designed to exploit more fully the potential of carbide and ceramic tools.

Other U.K. Interests

S. N. Bridges & Co. Ltd. continues to experience intensely competitive conditions; nevertheless, sales of the industrial range of portable electric tools increased; and more orders from overseas were obtained. The first stage of the rebuilding and modernisation of the newly-acquired works in York Road, Battersea, completed during the year, enables a higher output and a greater efficiency to be achieved, and plans are well advanced to launch new products.

Since the end of the financial year, the order previously given to **Cravens Ltd.** by London Transport Executive for 248 cars for the Amersham service has been increased by a further quantity of 216 cars for the Uxbridge service. Deliveries have begun of ten prototype underground cars, which incorporate interesting and original features, both in design and finish. During the year Cravens completed the Ship Tank Carriage for the Ship Hydrodynamics Laboratory (National Physical Laboratory), Feltham; this was a fine piece of mechanical engineering and construction. Sale of plastic injection moulding machines to the designs of Hydraulic Press Manufacturing Co. increased considerably during the year.

For **Markham & Co.** the difficult trading conditions reported last year continued during the first half of the year. Latterly, however, there was a better demand for its medium and heavy engineering products, and orders from the National Coal Board for several winding engines have been obtained. There is intense world competition in the water turbine field where Markham's manufacture for Boving's.

John Brown (S.E.N.D.) Ltd. serves as a sales, design, and contracting organisation for special projects, and as a means of deploying, in executing such projects, the manufacturing resources of the appropriate subsidiaries of the Company. An arrangement has been made with Demag A.G., the well-known German engineering firm, and a substantial order for rolling mill equipment has already resulted.

The Company, jointly with Solartron Electronic Group Ltd., has formed a new company, Solartron-John Brown Automation Ltd., to enter the potentially large field of completely automatic dispensing for warehousing and supermarket operation. The Company has acquired a substantial interest in Auto-Stackers Ltd., which is constructing at Woolwich this country's first automatic mechanical multi-storey garage. Sir Norman Hulbert has been appointed Chairman of both Solartron-John Brown Automation Ltd. and Auto-Stackers Ltd.

Constructors John Brown Ltd. was successful in securing a number of contracts for chemical plants and oil installations in the United Kingdom during the year, despite the general recession in capital projects in 1959, which has made competition keener. Latterly enquiries in this country have been scarcer, but work of the sort in which C.J.B. is interested is being offered in fair volume overseas. Much of it, however, requires credit, and many foreign competitors seem able to offer longer terms than those which British contractors can arrange, or for which insurance cover can be obtained.

Overseas Interests

The Company's overseas businesses increase continually in number and importance. In Canada, despite intense competition and other difficulties facing secondary manufacturing industries, the Company's three subsidiaries hold their positions and render important service to Canadian industry. **Firth Brown Steels Ltd.**, in its extensive warehouses in Montreal and Toronto, handles stainless and heat-resisting steels in many forms. **Firth Brown Tools (Canada) Ltd.** manufactures a range of engineers' cutting tools in its plant at Galt, and imports others from its parent company in Sheffield. **A. C. Wickman Ltd.** in Toronto holds a wide range of agencies for machine tools and other equipment and manufactures tungsten carbide tools and mining drills. In Africa, the conduct of business brings many anxieties, but the Board has confidence and believes that the Company's various organisations will continue to contribute industrially to the stability and increasing prosperity of these countries. **Wickman (South Africa) Ltd.** makes tungsten carbide rock drills and other tools. **Firth Brown Tools (Pty.) Ltd.** supplies Speedicut tools throughout the Union and Rhodesia, and has stocks and technical services available in several centres. F. Issels & Son Ltd. (in which the Company has a half share) in Bulawayo, in spite of heavy competition, has secured and completed important engineering work and has further developed its iron and steel foundries. Rhodesian Alloys (Pvt.) Ltd., in which the Company has a substantial stake, has operated to full capacity supplying to many world markets high quality low carbon ferro-chrome, an essential component of stainless steels. In Brazil, Wickman has taken a majority interest in an established company, Brasmac. A factory has been built in San Paulo in which sparking plugs for Champion International are being produced, various components for the automobile industry are being made, and manufacture of tungsten carbide tools will shortly start. The rest of the business of this firm is in importing machine tools. **Machine Tools (India) Ltd.** has continued to render an important service to the developing community, in the supply of machine tools to India, as agents of principals all over the world. A technical aid agreement has been made whereby Wickman will help an Indian company to produce tungsten carbide products, which Machine Tools (India) will sell. In Australia, **Wickman (Australia) Ltd.** continues, as importers and distributors of machine tools, to serve Australian industry and to increase its turnover; it also sells tungsten carbide tools manufactured in Australia at successive stages by associated companies. In the United States, Wickman is building a sales organisation to handle the distribution, through appropriate agents in various parts of the country, of machine tools made by the Company's subsidiaries and by others whose U.S.A. agency Wickman holds.

Westland Aircraft Ltd.

Westland Aircraft Ltd., in which the Company has a substantial shareholding, has emerged from the recent reorganisation of the aircraft industry as one of the principal groups after buying Saunders-Roe Ltd., the Helicopter Division of Bristol Aeroplane Co. Ltd. and Fairey Aviation Ltd.

General

Stockholders can be assured that new lines of activity are constantly being looked into and developed, either by way of extensions to the existing activities of subsidiaries, or by way of the acquisition of existing businesses, or by way of joining with suitable partners to found new enterprises. In this way the basis of the Company's activities is broadened, and the businesses of the existing subsidiaries, many of which face uncertainties and difficulties, are strengthened. Indeed, many of these new enterprises are deliberately chosen so that when they develop they may well provide work for, or otherwise fit in with, one or more of the Company's established subsidiaries.

It is remarkable how the ups and downs of the various businesses that comprise the Company's interests have, in recent years, offset each other, so that profits have steadily increased, a firmer base has been provided, and a financial strength has been built up that enables the Company both to continue its progress and to face with confidence whatever difficulties arise.

For this satisfactory state of affairs, and for the successful results of a year which, in many of the Company's businesses, has been far from easy, the efforts of the managements, the staffs and the workpeople of the subsidiary companies are largely responsible. To all of these the best thanks of the Stockholders and the Directors are due.

C769

Companies

Ferranti Advancing on all Fronts

WHETHER in machine tool control systems, transistorised computers or semi-conductor devices FERRANTI mounts an increasing effort in research and development.

Their annual report, presented by the chairman, Sir Vincent de Ferranti, tells a story of successful trading leading up to an increased profit before tax of £4,014,890, against £2,419,865 last year. This year's profit after paying tax was £2,123,390.

Most encouraging of all is the fact that orders, described in the report as "sales input," have increased to a record level.

Among the users of the Ferranti Pegasus electronic digital computer are banks, aircraft makers, insurance companies, oil concerns, universities, research establishments and a variety of industrial companies. Mercury, a computer ten to fifteen times the speed of Pegasus, is in use around Europe and as far afield as Buenos Aires.

The transistorised computer Sirius is in production and two more of the type, Orion and Atlas, are being developed, Professor Kilburn and his staff at Manchester University making a substantial contribution to the design of Atlas. Its first use will be on scientific problems where high speed is essential. It will operate between one and two hundred times faster than the Mercury computer.

Computer Centre

A new Ferranti computer centre is being set up in London for staff training and demonstration and also for those firms who want part-time use of computers. The centre will be equipped with Pegasus II, Sirius and Orion machines.

The extensive effort that has gone into semi-conductor devices is yielding returns and an extra wing has been added to the Wythenshawe laboratories to make more room for the work. The first of a further range of transistors to be introduced soon has been added to the Ferranti range.

The BENDIX AVIATION Corporation have now taken up the distribution in the United States of Ferranti machine tool control systems. A simplified computer control system has been produced, as have a position control system and a direct-reading coordinate inspection machine.

There was a record output of power transformers and associated equipment during the year. 45 per cent of this equipment was exported. Among overseas deliveries there were nine 330 kV units for the Kariba hydro-electric scheme and nine 180 MVA and some smaller units for the United States.

Orders for large power and distribution transformers has considerably increased, an opposite movement to the previous year when orders were declining. The two 310 MVA, 306 kV transformers for Blyth "B" power station are the largest yet ordered by the CENTRAL ELECTRICITY GENERATING BOARD.

Ferranti are the makers of more than half the electricity meters in Britain, a field where there has been considerable decline in both home and overseas prices. It has so been possible to meet the falling prices with reduced production costs.

Among the overseas subsidiaries, the United States FERRANTI ELECTRIC Incorporated expanded their capacity and had a successful trading year. A substantial interest was bought in the Australian WILSON ELECTRIC TRANSFORMER Company who have been Ferranti's transformer agents for many years. Technical and manufacturing information is to be provided to the company which have recently extended their plant at Melbourne to deal with larger sizes of power transformers.

FERRANTI-PACKARD ELECTRIC Limited in Canada, face tough competition in a difficult market. A Pegasus computer has been installed in Toronto, a new thermal demand meter has been introduced and the manufacturing space of the electronic division doubled.

Fodens Operating at Record Levels

Another record of substantial successes and of demand appearing to stretch into the future comes from one of the heavy commercial vehicle producers.

This time the good news comes from FODENS Limited. While the business is very competitive there is a steady improvement and the company's order books are in a very satisfactory position.

Mr. James Wild, the Foden's chairman, expresses his belief that a good volume of orders will continue.

There has been a substantially increased number of overseas orders despite the fact that conditions in some foreign territories make trading difficult. Production at the works was now running at record levels.

In many parts of the United Kingdom and overseas, the company maintain depots or have agents, all with factory-trained personnel, for the provision of customer service. This facility is to be improved by the opening of an all-purposes depot at Cardiff.

Optimism from an Electrical Manufacturer

Whatever the fate of electric appliance sales may be currently, there is no despondency about Mr. Raymond Berry, the chairman of BERRY'S ELECTRIC MAGICOAL Limited.

The company's output is continually being increased to meet a heavier demand which, at the time of Mr. Berry's annual report, showed no sign of decreasing. Hire purchase, he believes, is not a major factor in the sale of Magicoal products.

In the past financial year, the company's sales rose by 43 per cent and net profit before tax increased by 70 per cent, from £237,879 to £405,731. Selling prices have been held, and in some cases cut, over the past two years despite increases in wages, materials and some operating costs.

Exports increased by 10 per cent. Mr. Berry points out that this compares well with the all-up increase in the national figure of 5 per cent, and even better with the 6 per cent decline in British exports of domestic electrical goods.

A 25 per cent increase was achieved in Magicoal fires sold to the United States market and senior company staff are now engaged on sales visits to the USA, Canada, Australia, New Zealand, India and various European countries.

Looking ahead to colder weather, the chairman stated that the company would introduce a new electric blanket and a plate warmer before the winter.

Mr. Berry, for all the outstanding performance of the company, was not allowed to be optimistic throughout. Describing the future prospect as extremely favourable he made this reservation—trade recessions are infectious and it would be unwise to turn a blind eye to unpredictable measures which the the Government may take.

Colchester Lathe Scandinavian Tour

Continuing its vigorous sales efforts in Europe the COLCHESTER LATHE Company has sent one of its demonstration coaches on an intensive tour of Scandinavia. It is to spend a month in each country, taking in Norway, Finland, Sweden and Denmark.

Industrial users will see demonstrations of Colchester equipment and

arrangements have also been made to visit technical schools and colleges. The crew operating the demonstration coach are the same people that toured with the lathes in Britain, Northern Ireland and in Eire.

The team is led by Mr. A. J. Plowman, on the left in the picture, the Colchester Lathe sales director. The company reports a very good response to the tours in the UK and in Eire. It has confidence in the outcome of the Scandinavian trip to three countries who are members of the European Free Trade Association and to one, Finland, that is interested in association with EFTA.

Other Colchester demonstration teams are at present in Switzerland and Germany. Later this year they will be taking in Austria and other parts of the European market. Eventually it is intended that the coaching sales teams should tour other continents.

The company explains "The best way to approach export markets is to prove to the potential user that the machines you can offer are just what he needs. Practical proof of the machines' ability outweigh any other sales method."

Demand Very High for Locks and Safes

With the indictable offences graph at the Home Office moving rapidly into an even steeper upward curve it is not surprising that the safe-making firm of CHUBB AND SON report that last year they enjoyed a record turnover.

All the firm's production sections were fully extended in meeting the demand and now there are claims, reported the chairman, Mr. G. C. H. Chubb, for further development in many directions.

Turnover was maintained in the export markets. At home, a new range of locks is being put on the market.

The company have successfully introduced the new Chubb Anti-Arc Alloy, this is on the banking side of their activities. Fire-resisting office equipment sales have improved.

There are subsidiaries in Australia, South Africa and Canada. In Australia, important factory extensions and improvements are approaching completion. Substantial orders for architectural metalwork have been obtained. Many sizable banking installations have been made in South Africa in a year of "great strain" for the company's employees.

The profits of the group before tax were £552,008, against £414,504 in the previous year.

New Hydroelectric Division for English Electric

A new division within the English Electric Company is to be formed to combine all aspects of the company's hydroelectrical engineering at its Netherton Works, near Liverpool. From 1 September, 1960, the new hydroelectric division will be responsible for the commercial, engineering and manufacturing operations connected with hydroelectric installations, including the design and manufacture of turbines, alternators and large valves.

The manager of the new division will Mr. J. Gavin Warnock, at present manager of the hydraulic department of English Electric's Canadian associate, John Inglis and Company of Toronto.

The division will be formed by moving the staffs of the design, projects and mechanical development sections of water turbine department, at present at Rugby, to join the water turbine alternator section already at Netherton. The Netherton factory covers 70 acres and the five heavy machine shops are able to manufacture complete hydroelectric plant, up to the largest sizes, for world power systems. The hydraulic laboratory, one of the best equipped in the world, will form a part of the division but will remain at Rugby. Approximately 60 members of the Rugby staff will be involved in the move.

Since 1920, when English Electric began to design and manufacture water turbines, Rugby-designed machines, including some of the most powerful units in the world, have been manufactured in Canada and in England and Scotland mainly for export. The total power of all the turbines produced now approaches 12½ million horse power.

Pakistan Oil Refinery and More Exploration

The estimates have been submitted to the Pakistan authorities for the oil refinery to be built near Karachi.

A four-company consortium is sponsoring the project. They are BURMAH OIL, SHELL, STANDARD VACUUM and CALTEX. Pakistan's oil consumption has been meagre for years but it has now risen to about two million ton as year and is expected to rise rather more swiftly in future.

Oil exploration investment in Pakistan this year has been raised by 10 per cent over last year. The Government finds 25 per cent of the costs.

Friction Welding: A Practical Process

The direct conversion of mechanical to thermal energy used in a friction welding machine gives it a low energy consumption. This fact alone should make friction welding an attractive process.

BASICALLY, friction welding entails the heating of two surfaces to be welded by the heat generated when they are rubbed together. When a high enough temperature is reached the two surfaces are forced together so as to form the weld.

In the simplest case, one surface is rotated against another held stationary. The basic variables, i.e., the temperature to which the weld surfaces are raised and the upsetting pressures, are similar to the variables with other pressure welding methods, i.e., flash butt welding. In friction welding, however, only a small volume of the material is heated by a fast direct conversion of mechanical energy to thermal energy. This means that the process has a relatively low energy consumption.

The invention of this method of welding is attributed to A. I. Chudikov, a Russian engineer. Details of the process have been published recently in the journal *Czechoslovak Heavy Industry*.

PROCESS

Fig. 3 shows characteristic plots for the friction welding process, which can be divided into a preheating and an upsetting period. The process begins with contact of the surfaces to be welded under the influence of a preheating pressure. After contact, an increase of the friction moment occurs which lasts for the period of dry friction, i.e., until the material becomes plastic. Friction moment rises with increasing preheating pressure and with increasing diameter of the material to be welded. The type of material has little effect on the friction moment.

When the material becomes plastic, the friction moment falls off to a value which is almost constant. The preheating period finishes when the required welding temperature has been reached and a sufficient volume of material has been heated up. The upsetting pressure is then applied before rotation is stopped.

The introduction of the upsetting pressure is followed by a decrease of the friction moment caused by the decrease in speed of rotation and the formation of the weld.

The basic factors of friction welding are then as follows:

(1) Speed,
(2) Preheating pressure,
(3) Upsetting pressure, and
(4) The time delay between application of the upsetting pressure and the stopping of the workpiece rotation.

In order to obtain a good weld, all these factors must be controlled.

Theoretical computation of the heat transfer which takes place during the process shows that the intensity of the heat generation in the contact surfaces of the workpieces depends on the physical properties of the material, e.g., the coefficient of friction, the thermal conductivity and the specific heat. Calculations show that the heat generation is not uniform throughout the entire weld cross-section, a fact which also results in unequal heat distribution (parabolic). Before the entire cross-section changes to the plastic state, the maximum temperature is in a circle of 2/3 of the diameter of a solid circular workpiece. After a very short time, the temperatures are equalised and, in the next phase, the heat-affected zone spreads from the centre of the contact area to the perimeter (Fig. 2).

A typical characteristic of friction welding is the approximate state of equilibrium which is reached in the contact zone of the weld shortly after the transition to the plastic state. The temperature in the direct vicinity of the contact surfaces of the weld, measured by an optical pyrometer, is approximately 1,200° C.

It has been found by experiment that the friction weld originates in the austenitic range of temperatures, i.e., temperatures higher than transition temperature A_3 of hypo-eutectoid steels and A_{Cm} of hyper-eutectoid steels. It has also been shown that the temperature is not higher than the melting temperature. It can therefore be assumed that the theory of friction welding is closely related to that of cold and hot pressure welding.

RESEARCH

Research into friction welding technology was carried out on pilot-plant equipment. The chief aim was to gain data for the design of special welding machines, and to determine the fundamental principle affecting the weld quality.

In order to simplify all the relationships, non-alloyed low and high carbon materials were chosen for studying the effects of the invididual

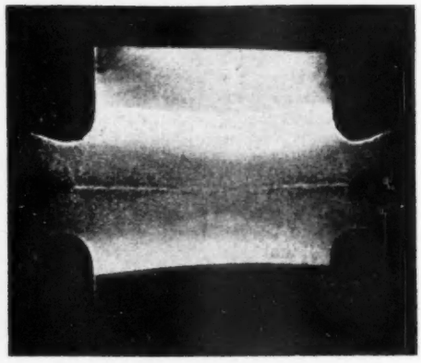


Fig. 2 Cross-section of a friction weld.

variables on the quality of the weld. The test results showed that the quality of the weld depends mainly on two factors, namely temperature and contact pressure.

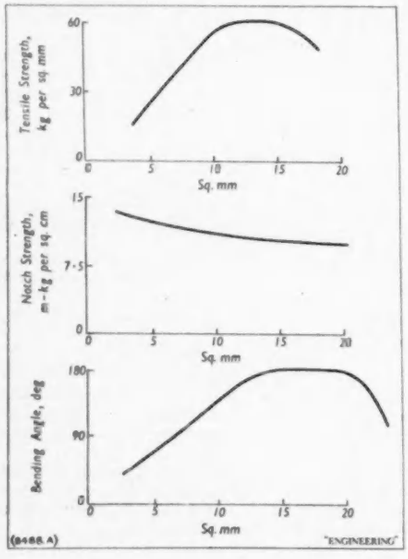
In addition, as already stated, the welding process can be divided into two periods, the preheating period and the upsetting period. Each period has its own specific effect on the weld quality.

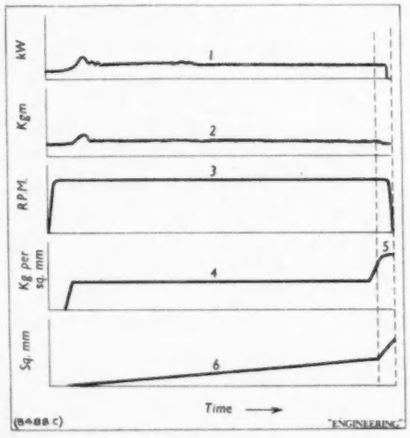
The preheating period must supply a sufficient quantity of heat to bring a certain amount of material, determining the weld quality, to the plastic state.

Overheating, i.e. prolonged preheating, leads to primary grain growth in all materials. The coarsening of the material is especially noticeable in materials with a higher carbon content, which have a lower temperature of the critical primary grain growth.

The comparison of grain sizes of samples heated at 1,100 and 1,800 r.p.m. leads to the conclusion that the grain structure will be much finer at lower speeds than that of samples preheated at higher speeds. This leads to a second conclusion that there is a lower equilibrium temperature at 1,100 than at 1,800 r.p.m.

The speed of revolution also has various effects on the preheating period. At lower speeds the plastic zone is immediately extended into a flash. At increased speeds only partial deformation occurs during the preheating period, the material being heated to depth and the change of cross sectional area (upset) being small. At





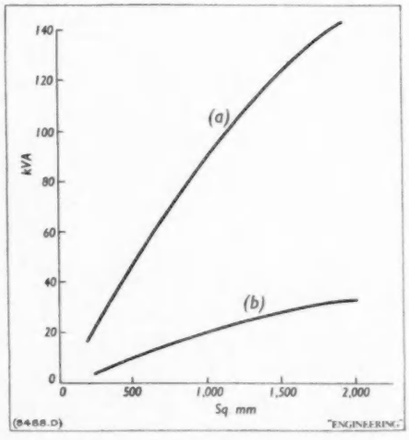


Fig. 1 (left) Typical relationships between mechanical properties and overall upset. Fig. 3 (centre) Graphical representation of the friction welding process. Curve 1—Input power. 2—Friction moment. 3—Speed of rotation. 4—Preheating pressure. 5—Upsetting pressure. 6—Upset. Fig. 4 (right) The installed electrical input of (a) electric flash butt welding and (b) friction welding.

the end of the preheating period, considerable grain coarsening sets in.

A basic requirement of the welding process is, therefore, to eliminate grain coarsening as far as possible. Tests have shown that this coarsening can be eliminated, at least partially, by the correct selection of variables during the second stage of the welding process, the upsetting period.

It is known that re-crystallisation of the material can be achieved by the plastic deformation of the material when heated. The tests showed that plastic deformation during the friction welding process can occur only if about 50 per cent of the overall upset is caused by the upsetting pressure. The plastic deformation caused by the preheating pressure, which is an accompanying effect of the preheating of the material, does not in any way help to improve the weld quality. In order to achieve the plastic deformation of the material during the upsetting period, the preheating to upsetting pressure ratio can be varied over a wide range.

The actual upsetting pressure used is much the same as that used in flash butt welding. It influences the notch toughness of the joint and values around 8 kg per sq. mm are commonly used. The depth of the preheated zone of the welded material is initially affected by the magnitude of the preheating pressure. In view of the fact that the plastic deformation of the material during the course of the upsetting period affects the weld quality, the magnitude of the upsetting pressure is selected according to the type of material to be welded. For welded joints which do not require further heat treatment, the preheating and upsetting periods should be such as to attain recrystallisation of the material during the upsetting period. For welded joints which are subjected to further heat treatment after welding, the above mentioned condition need not usually be fulfilled and greater preheating pressures can be used, which result in the shortening of the preheating period, which in turn means the shortening of the entire weld cycle.

DRESSING

Excessive stressing of the machine can occur during the welding of large diameter parts at low speeds, especially during the dry friction period before the transition of the material to the plastic state. The speed selected must, therefore, be such as to ensure the least possible stressing of the machine, whilst at the same time fulfilling the technological conditions which must be met in order to produce a satisfactory weld.

A further factor which must be taken into consideration in friction welding is the overall upset. This is the sum of the upset which takes place during preheating and the upset which occurs during the upsetting period.

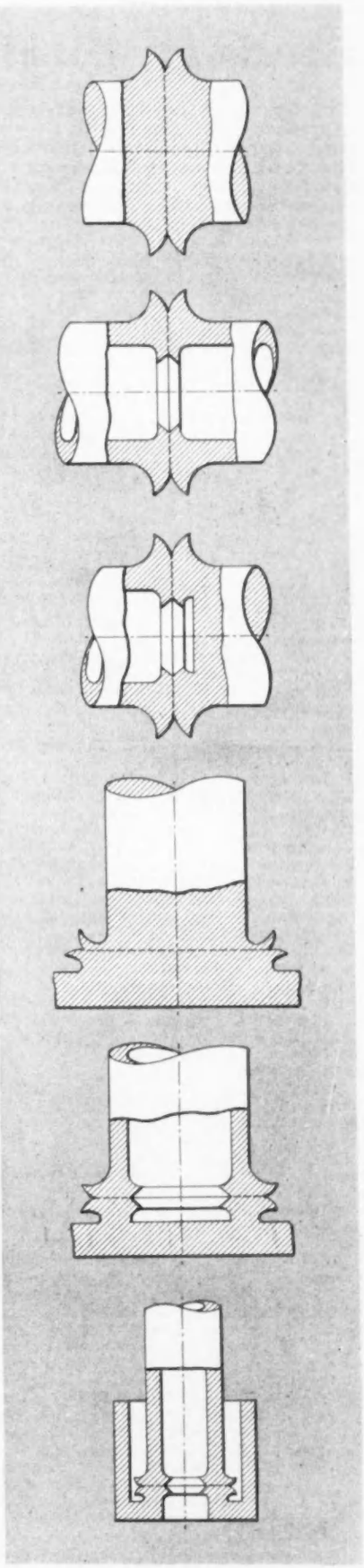
This overall upset depends partly on the type and diameter of the welded material. It increases with rising carbon content. A certain optimum upset does, however, exist which results in the best weld quality. If this optimum point is exceeded, the weld quality deteriorates. Typical curves for mechanical properties and overall upset are shown in Fig. 1.

Nearly all types of steel, aluminium, copper, duraluminium, titanium, bronze and brass can be friction welded. The technological conditions for welding combinations of materials of basically different chemical composition are much more complicated than those for welding approximately similar metals. When welding materials with similar thermal conductivity properties including high alloy materials, however, a good weld can be achieved because both parts are uniformly heated.

To attain a good quality weld, the cross sections of the workpieces in the neighbourhood of the contact areas must be dressed in such a way that there is equal thermal flow in both parts. In special cases, such as in the welding of circular cross-sections to flat plates without recesses, the cross-section of the circular stock must be greater than the thickness of the plate, in order to achieve thermal equilibrium and to prevent an excessive heat flow to the plate.

The contact surfaces for welding need not be absolutely flat, a straight saw cut is sufficient. The parallel alignment of both contact surfaces must be ensured, though they need not be clean.

Fig. 5 Typical joints which can be friction welded.



The best test for weld quality, especially for pipe joints, is a bending test when the materials welded are suited to this type of testing (as in resistance welding). A tensile test alone is not enough because a strengthening of the material frequently occurs in the weld region and fracture takes place away from the weld. This may occur even when the weld has not been carried out under the optimum conditions.

FRICTION WELDING MACHINES

The inventor of friction welding made his first welds on various types of lathes, and this welding process can be performed on any suitably modified rotating machine tool. However, it is reported that modification is not the answer from the economic point of view. Reliable and economic production can only be achieved on special machines designed solely for friction welding. These should combine the characteristics of a single purpose lathe with a press of very robust and rigid design, together with hydraulic control of the welding process. The process should be automatically controlled in order that the machine should reproduce optimum conditions for a good weld every time.

As a result of thorough production tests on pilot-plant equipment and research into friction welding technology, the prototype of a special friction welding machine has been designed in Czechoslovakia, the ATS 20. It is a universal machine which gives speeds for welding steel and non-ferrous metals varying in cross-section from 300 sq. mm to 2,000 sq. mm. The maximum upsetting force in this machine is 20 tons. In one variation of the machine, both parts of the work are held in hydraulic chucks, and the maximum length of material at the spindle is 200 mm, the length of material on the upsetting side being unlimited. Among the jobs which this machine will do is the welding of rotating tools composed of high speed and carbon steels, gear wheel forgings and turbine rotors.

The machine is hydraulically controlled and fully automatic, and has an independent hydraulic power unit. After gripping the workpieces in the hydraulic chucks, the machine operates automatically according to preset variables. These include automatic opening of the chucks at the end of the welding operation, and fast reverse travel of the upsetting unit to its initial position for the chucking of the workpieces for the next welding cycle. The machine is also equipped with an auxiliary machining carriage for machine dressing of the workpiece before or after welding, if this is desired.

There are two alternative means for controlling the welding cycle. This can be done either by fixing the time of the preheating period, or by a device which measures the upset occurring during the preheating period.

Friction welding is not a universal method of welding because it is limited to working which the cross-section of the contact area is either full circular or tubular. The complete workpiece can of course be of any desired shape.

Compared with some of the conventional welding methods, for example, electric resistance butt welding, the friction welding process has many advantages. The installed electrical energy input is very much lower, see Fig. 4, and welding proceeds without the unpleasant input peak. This results in a lower kWh per sq. mm consumption for the welded cross-section in the same welding time.

The clean operation of the machine without any flashing or sparking will make friction welding very attractive to production engineers, because the machines can be placed in production lines among other machine tools without causing any discomfort or creating a need for special safety precautions.

At least one company in Great Britain is interested in making friction welding machines.

Saving Fuel by Heating Intermittently

A comprehensive study of heating in an office block is underway. Initial results emphasise the fuel saved by intermittent heating and suggest boiler start-up be controlled by return water temperature.

Most office blocks have central heating. One of the commonest systems is to supply hot water to a number of radiators from a boiler. So well known and so widespread is this system that it comes as something of a surprise that the Heating and Ventilating Research Council should be devoting considerable effort to finding out how such systems should be operated. The implication is that a good many office blocks have not been heated in the most economical manner. In the particular block investigated by the council, a successful scheme of intermittent heating showed a saving in fuel of 50 per cent compared with continuous heating.

A limited amount of information can be obtained from general assessments of fuel consumption and by simplified theoretical treatment. However, the council decided that a full understanding of the influence of different variables in the heating of a building could not be reached by these methods and decided on a more practical approach. The method involves a continuous measurement and analysis of the conditions occurring in an actual building (building and heating plant temperatures and flow conditions, rates of fuel consumption, and weather conditions) on an hourly, daily, and weekly basis throughout the heating season.

OFFICE ROUTINE

They chose a building just off Oxford Street, London. It has parts five and six storeys high, contains 124 rooms, and has a heated volume of 400,000 cu. ft. The design heat loss, computed for 65° F inside and 30° F outside, is 1,310,000 Btu per hour, including mains loss. The external walls are of brickwork, 9 and 13½ in thick. Two oil fired boilers feed conventional low-pressure hot-water radiators through a two-pipe rising system. When the desired air temperature in the building is reached, a thermostat brings a 3-way mixing valve into operation, which allows various proportions of by-pass from the return to flow pipe in accordance with the outside temperature, by means of a thermostatic controller outside the building. The burners are of the on-off type under the control of a thermostat in the flow main.

The heating cycle of the building divides into three periods during each day. The first is the boost period when the heating plant starts up at 6 a.m. and puts heat back into the building after the overnight temperature fall. In the second period, after the boost, the heating reaches its steadiest condition, which continues until 6 p.m., when the heating ceases. Finally, there is the overnight period when the plant is shut down. There is no heating at weekends.

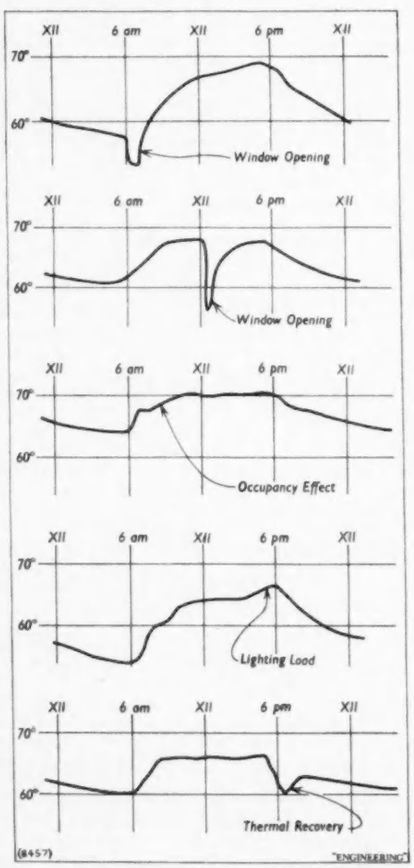
To analyse the behaviour of the building, thermographs were placed in 24 of the rooms, flow and return temperatures were continuously recorded, and the length of time for which each boiler was being fired was determined from operation recorders on the burners. The rate of fuel consumption and the daily totals were also recorded. Preheating was not controlled automatically but the changeover to normal running was automatically effected at a predetermined air temperature. With the particular installation studied, there was available a boiler power equal to 1·6 times the steady design load. At 30° F outside temperature, preheating was required for about three hours with both boilers; at 40° F for about 2½ hours with both boilers or about 4½ with only one.

The first result demonstrated by the thermographs was the fact that at any one time room temperatures throughout the building could vary by 10° F. Also demonstrated was the effect of the occupants. As the illustration shows, temperatures change markedly with the opening of windows and doors, the body heat of the occupants, the amount of lighting used, and the thermal lag of the structure.

From noon till 6 p.m. the average building temperature remained substantially constant at about 65° F. During this period the heat input was proportional to the difference between the temperature inside and outside the building. When the actual variation is expressed graphically, the intercept on the temperature axis indicates that the heat input due to occupants and radiation is equivalent to the maintenance of 5·7° F excess over the outside temperature. A check on this figure is provided by the fact that burner operation stopped at an outside temperature of 59·4° F. As burner operation stops when flow water temperature is the same as inside temperature, 65° F, the excess temperature over the outside temperature, 5·6° F, is accounted for by the occupants and radiation. A rough estimate of the metabolic and lighting heat outputs also agrees with this estimate.

PREHEATING BOOST

The temperature reached at the end of the preheating period varied from day to day between 61° F and 66° F and averaged 64½° F. Although on occasions, notably in mild weather, only one boiler was in operation during the boost period, the total fuel used during the period was the same whether one boiler or two operated. When, however, the total daily fuel consumption was plotted against indoor-outdoor temperature difference with one or two boilers operating, it was found that more fuel was used when two boilers were employed.



The danger of relying on isolated temperature readings in assessing the performance of a heating system is illustrated by the marked variations in temperature that may occur in the course of the day. These are typical thermograph records.

Economies of Intermittent Heating Compared with Continuous Heating Of A Building To 65° F.

1. Building maintained at 65° F from 9 a.m. to 6 p.m., minimum temperature during the night 62° F: 10 per cent fuel saving.
2. Building maintained at 65° F from 9 a.m. to 6 p.m., minimum temperature during the night 60° F: 20 per cent fuel saving.
3. Building maintained at 65° F from 9 a.m. to 6 p.m., and allowed to cool freely during the night: 40 to 50 per cent fuel saving.

Two explanations are suggested for this phenomenon, but both probably contribute. First, the building temperature at 9 a.m. was somewhat higher when two boilers were used, owing to the faster rate of heating. There is some reason for supposing that the higher morning temperature led occupants to open more windows, increasing the heat loss and fuel consumption. Second, an additional heat loss was found from the second boiler when it was in operation. By chance, a plant failure enabled this to be assessed and when data are corrected for the increased boiler loss the fuel consumption for one or two boilers agree quite well.

The method of applying boost, however, could be improved. In mild weather it is not necessary to start the preheating at 6 a.m., as the building will reach its normal temperature well before the arrival of the occupants, and fuel will be wasted. A new form of starting control is being devised to operate from the return water temperature. This should enable useful economies to be made.

OVERNIGHT COOLING

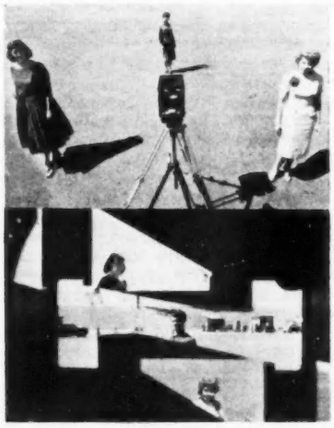
When heating was shut off at 6 p.m. there was a rapid fall in air temperature during the first hour or so, followed by a slower fall during the rest of the night, corresponding to a thermal time constant of 2 hours. It seems that during this initial period the structure itself lost very little heat but that the air change by ventilation was sufficient to remove the heat stored in the furniture. There was a significant partial correlation between the fall in temperature after one hour and the morning and late afternoon outdoor temperatures, but none with the noon temperature. The correlation with the morning temperature represents the effect of the time lag of the solid parts of the structure; while the correlation with the late afternoon temperature shows the effect of the small time lag of the glass and the ventilation.

The longer overnight cooling appeared to be Newtonian in character, with a time constant of about 40 hours. The overnight fall, up to the start of preheating, was about one-third of the temperature difference between the design indoor temperature, 65° F, and the average outdoor temperature during the cooling. Certain rooms, however, showed substantially greater cooling rates, but there are not sufficient data to explain this.

When cooling was allowed to continue for longer periods, as at weekends, the Newtonian time constant became 109 hours. The difference between this figure and that for overnight cooling possibly shows the greater importance of the internal partitions and floors in relation to sus-

Three View Camera for Landing and Take-off

To evaluate the performance of aircraft during take-off and landing, Lockheed Aircraft Corporation, California, have a camera system that takes pictures in three directions at once. The camera is mounted in the aircraft. Previous studies of aircraft take-off and landing had been carried out using ground cameras tracking the aircraft through calibrated screens. The new method reduces the number of technicians needed for such studies from seven to one—a weather observer. Also the ground equipment previously used—the theodolite cameras, surveying equipment, and portable power supply—is no longer needed. It is claimed that the new method will cut testing time by about two-thirds.



The camera with its mirror attachments, and a still picture from the camera, are shown in the illustration. When mounted in the aircraft the camera lens extends out from the lower fuselage. Thus three images appear on each film frame: the view down the runway and views right and left of the runway. In addition a stroboscopic light flash inserts timing markers in the frame's margin every fifth of a second. Using the known runway dimensions in conjunction with the time markers it is possible to compute the aircraft's velocity, acceleration, attitude, altitude, pitch, roll, and yaw. The actual procedure followed is to project the film on a standard film reading device and the record is automatically punched into IBM cards for processing through a digital computer. Results are plotted on graph paper at a rate of 100 points per minute.

Already in use by both its California and Georgia divisions, the device has been sold by Lockheed to other aircraft manufacturing firms. It costs £2,700.

Last Anti-Submarine Argus Leaves Assembly Line

2,442 tons of anti-submarine aircraft have been put into the air by Canadair Limited, Montreal, now that they have delivered their thirty-third TL-28 " Argus." Like its 32 predecessors, which have been rolling out since 1956, number 33, the last, will join the Maritime Air Command of the Royal Canadian Air Force. The aircraft are designed to detect, locate, and destroy submarines They carry four tons of weapons, including homing torpedoes and depth charges.

Canadair's total contract for the CL-28's amounted to about $170 million, including spare parts, modifications to up-date early models, mountains of technical manuals, and the training of RCAF technical personnel. The programme involved about 21 million man-hours—about 16 million by Canadair personnel and 5 million by the personnel of their suppliers and subcontractors; in all, nearly 2,000 Canadian companies shared in the work. It has been estimated that of the total $170 million, about $80 million will find its way eventually into the treasuries of the federal, provincial, and municipal governments in taxes of all types.

Up to 1 July, the Argus aircraft had logged a total of about 21,000 hours, or more than 4,700,000 miles. One, aloft for 26¼ hours, covered about 6,000 miles on a routine mission. An operational crew of 15 is carried.

Caravelle Lands after Mid-Air Collision

A remarkable landing was made by a twin-jet Caravelle after another aircraft collided with it and removed a large portion of the cabin roof. The aircraft was making the normal Algiers to Paris trip and was preparing to land at Orly Airport, after having received authorisation to do so. Then a Stampe pleasure aircraft collided with it from above at an angle estimated to be 110°. The accident occurred at an altitude of 2,000 ft and the engine of the Stampe broke through the cabin of the Caravelle, where it remained after dropping off its airframe. The airframe caused further damage to the spine and tail unit of the aircraft.

At the moment of impact, the engines, which had been operating at reduced speed, stopped, but the pilot succeeded in starting them up again. Debris in the starboard engine, however, prevented it from running above 5,000 r.p.m. Radio communication with the control tower could not be re-established, but wing flaps and landing gear could be extended normally and a landing was made. The pilot was able to taxi to the parking area without outside help.

Subsequent examination showed that some 10 metres of the upper right quarter of the cabin had been torn away and frames 13 and 16 (which surround the forward door) and frame 31 (linking the fuselage and wings) were severed. The Stampe's engine was lodged between the seats in the cabin; one of its wheels was embedded in the forward blading of the starboard engine. One passenger was killed, and seven injured.

Flying Boats Fight Forest Fires

How about taking the Princess flying-boats out of their cocoons and using them as fire engines? After all, we might get another summer like that of 1959, along with the forest fires. The giant flying boats could pour water down on them from above.

This thought is prompted by the report that an 80-ton Martin Mars flying boat was used to help get the worst of British Columbia's many forest fires under control. Carrying 7,000 gallons of water, the Mars made 8 runs along the leading edge of a fire to cool it so that men and bulldozers could build a firebreak. Between runs the aircraft reloaded with water through scoops, while taxiing on a lake.

Television Camera Looks at Wheel and Rail

Observation of events in places inaccessible to normal visual observations has become an important task for closed-circuit television. Quite often the camera has to be placed in a position that is apparently quite unsuitable for delicate electronic apparatus. As a result, the industrial television camera has developed into a rugged instrument which with careful mounting can go virtually anywhere. A recent example is the use of Marconi closed circuit equipment by Rhodesian Railways. As shown in the illustration, the camera was mounted close to the wheels of a locomotive.

Rhodesian Railways were anxious to study the behaviour of wheel and track to see if there was any peculiarity which could account for the abnormal wear occurring on sharp curves of the track between Umtali and Salisbury. The camera was mounted in sponge rubber in a steel container bolted on to a special bracket. A spot light was also attached and the whole assembly was placed in a number of different positions so that the behaviour of each of the wheels could be studied in turn.

The monitor screen of the equipment was installed in a private saloon on the train, where engineers could watch the behaviour of the wheel and track as the train went along. To provide a record of the tests a ciné film was made of certain sequences appearing on the screen.

Concluding **Saving Heat**

tained cooling. It seems likely that for design purposes the two time constants should be used according to the circumstances. The shorter is applicable to heating up on ordinary weekdays, and the longer to heating up on Monday mornings or after holidays. This conclusion is supported by the observations that Monday morning temperatures tended to be low, showing that insufficient preheating had been allowed.

A significant finding was that the temperature of the return water in the morning before preheating started was highly correlated with the building air temperature. That is, the return water temperature reflects the cooling that has taken place in the building. This suggests the possibility of controlling the time of burner ignition—and so the duration of preheating—in accordance with the return water temperature. The proposal has the merit that a single temperature is adequate to represent the average cooling of the building. Accordingly, a device has been produced which ignites the burners by means of a sensing contact thermometer in the return line operating a sequence controller.

The behaviour of this particular building is the subject of a report by Mr. K. J. Colthorpe and Mr. E. E. Stanley. It represents the start of a comprehensive research programme and the results already obtained will lead to further reports on the suitability of different methods of measurement and on variations in weather and the behaviour of occupants. Work is also underway to study the heating of a building using panel heaters, and further buildings are likely to be examined.

On the Shelf

By Frank H. Smith

ISLINGTON Public Libraries dish out information with such enthusiasm that I positively strain myself to find a hook on which to hang a mention each time I get their gubbins. This time I take their offer of a list of the directories, annuals, year books and trade registers (600 plus). You can get one at the counter; write to Central Library, 68 Holloway Road, London, N7; or ring NORth 4038, extension 3. Their typical query this month is " Who makes stroboscopes?" Kid's stuff. (Anybody know what a stroboscope is?) The idea I do like about Islington is the provision of quiet rooms for the children to do their homework. And what better place to do your homework than slap in the middle of a library?

The Norton Grinding Wheel Company Limited, Welwyn Garden City, are (you've guessed it?) manufacturers of grinding wheels, abrasive products and allies. They send us copies of the American house's journal *Grits and Grinds* (on which one is tempted to do an Accles and Pollock act) and apologise that not every edition is imported and some come out of order. That's fair enough but a bit trying on a systematic librarian. Odd copies tend to be thrown away during a clear-out whereas a neat numerically complete collection tends to be kept because it looks so nice. It is quite an informative journal and there are not all that number on that subject so it is a pity that they aren't regular. Perhaps one could write direct to Norton Company, Worcester 6, Mass., and get the lot? Perhaps. That's what I'd do if I wanted it for my library.

The first issue has appeared of *Canning Journal*, which does not deal with free trade. The sub-title is " Electroplating and Polishing News " and comes from W. Canning and Company Limited, Great Hampton Street, Birmingham 18. It's a bit skinny for a start but perhaps it will fatten up as it goes along. Perhaps they'll use items other than those devoted entirely to their own products? (I charge nothing for hints like this.) After all, if you are going to start a house journal you might as well make it worth having.

Are you connected with steam (as the attendant said in the Turkish bath)? Spencer-Bonecourt-Clarkson Limited (they must be compound engines), engineers and boilermakers, of 28 Easton Street, London, WC1, are issuing, three times a year, to several thousand steam users in Britain their *Steam in Industry*. It is an aristocratic looking production and if you do not get your copy I suggest you write (or ring TERminus 7486) a message with the gist " Hi! I use steam."

Copyright can be an awful bind and it is interesting to note the preface to " Classified Index of Computer Literature " (London Computer Centre, 68-71 Newman Street, London, W1, MUSeum 5040) which says " It should be mentioned that all the documents are COPYRIGHT and, in view of the facilities available for obtaining them in any quantity desired, none may be reproduced in whole or in part." Can't say fairer than that.

An illustration in the July ASME's *Mechanical Engineering* shows a scheme whereby an airship carries a 40-ton rocket-booster from place to place without regard to such things as tight corners and low-lying bridges and what have you. Now here's an idea for those thumping great transformers and things that have to spend their weekends going all round Wales to get from Margate to Cliftonville.

Pergamon (Headington Hill Hall, Oxford) offer a new translatory (sic) service, and lest you think Pergamon is trying to leave its mark on the dictionary whose patronymic is the town of their adoption, let me quote from the *Shorter:* " of or pertaining to (physical) translation." They'd better think again, perhaps?

Surface Wetting Metal

Tin and Its Alloys. Edited by ERNEST S. HEDGES. *Edward Arnold.* (126*s*)

Tin is a common metal with a long history in the service of man. A book on tin, however, is a rare thing and there is no doubt that this present volume fills a real gap on the shelf. This is particularly so because the several authors are acknowledged experts on the metal and its varied applications.

The most useful property of tin is its natural corrosion resistance but it has only been possible to exploit this economically by making use of another important property of the metal. Tin has a low melting point, 232° C, and when molten will readily " wet " the cleaned surfaces of many other metals. These metals can then be coated with a thin layer of tin so that full advantage can be taken of their own particular properties together with the corrosion resistance of tin.

This property is the basis of the tinplate industry and although the thickness of the tin coating on the steel is commonly as little as 0·00003 in, this application of the metal accounts for well over one third of the world's usage. Much of this tinplate is used for canning foodstuffs and other materials and some idea of the importance of tin in this respect is reflected in the fact that we call these containers " tins."

In this book, which is directed as much to the engineer as to the metallurgist, the appropriate space is given to the production, properties and applications of tin as a protective coating. The limitations—and tin is no more the panacea for all corrosion troubles than any other material—are not glossed over but discussed frankly and usefully.

Apart from coatings the main use of tin is in the solders and bearing alloys. With solders the wetting power of tin is again the important factor but in the bearing alloys a third characteristic becomes all important. When alloyed with other metals tin tends to form hard and rather brittle intermetallic compounds such as SbSn and this property is made use of in the Babbitts, white metals and tin bronzes. The good bearing properties are obtained by adjusting the composition of the alloys to give structures consisting of these hard phases bonded together by a softer but more ductile material such as tin, lead or copper. This same feature is also utilised in the type metals.

All these applications and other more minor ones are given their correct emphasis and dealt with in separate chapters. There is also a short chapter on the physical metallurgy of tin and another on its chemical behaviour, dealing particularly with corrosion characteristics.

All this information on tin is related by the introductory section and Dr. Hedges is to be congratulated on the unity he has wrought from the work of five authors. There is very little new information—the book is rather a gathering together of all the known facts—but there are some previously unpublished results on the white to grey tin allotropic transformation. This evidence should surely scotch, once and for all, this ancient bogy and satisfy users of tin and tin alloys that there is no real danger from this source even in low-temperature applications unless the tin is exceptionally pure.

It would be difficult, if not presumptuous, to criticise a book written by such authoritative people. It is easy to think of points left out (would the book be more complete with a chapter on the extraction metallurgy of tin?) but a line has to be drawn somewhere and the contents strike a sensible balance between theoretical considerations and practical knowledge. Finally, the book is excellently produced with adequate illustrations, many useful tables and an extensive bibliography.

J. R. HALL

Oil Field Theory in Practice

Applied Petroleum Reservoir Engineering. By B. C. CRAFT and M. F. HAWKINS. *Constable.* (62*s* 6*d*)

Textbooks devoted to the subject of petroleum reservoir engineering are few in number, as compared with the literature available in other applied sciences. Where the fundamentals of the art or science are treated in the literature, theory and technique are presented in a form which is rarely directly applicable by practising engineers to problems in the field involving interpretation and prediction of reservoir behaviour or concerned with control procedure. The recent publication by Prentice Hall of the volume entitled *Applied Petroleum Reservoir Engineering* by Professors B. C. Craft and Murray F. Hawkins Jnr., of Louisiana University is therefore welcomed not only as an addition to a meagre library but also—and mainly—because much of the published and accepted theory and principles is presented clearly in such a manner that it can be applied with facility in field practice.

This book may, therefore, be regarded as complementary to previously published literature, much of which is concerned primarily with the fundamentals of the art of petroleum reservoir engineering. As such, it succeeds in a clear and concise way, the methods of application being demonstrated by actual field examples, together with a broad selection of specific problems and answers. In fact, this is the outstanding feature of the book.

The topics selected for discussion exclude geological, geophysical and bore-hole surveying techniques and interpretation, and the text does not extend to detailed discussion of laboratory methods, equipment and practice, or to the relative merits of different means employed in providing some of the basic data. Other spade work involved in evaluation of basic and other parameters is also largely omitted from detailed consideration.

The impression conveyed by a perusal of the subject matter of the volume is that the intention of the authors has been primarily to provide a book dealing with the practical application of the science for students and for practising engineers in the field, who already possess a sufficient knowledge of field surveying, laboratory practice and some background knowledge of sedimentary geology. As the book is almost entirely concerned with practical application, this comment is not offered as a criticism, but simply to indicate that the scope of application has been limited by the omissions referred to above.

In more critical vein attention is drawn to the treatment afforded in reservoir study of cases characterised by significant segregation of oil and gas. A statistical comparison of fractional gas flow rates in reservoir output with those indicated by simple depletion drive may signify that segregation has occurred on an appreciable scale in past behaviour and is valid to this purpose. In fact, this statistical procedure is referred to in the literature, but segregation, as a phenomenon, is a fundamental component driving mechanism and in order to extend study beyond observation of its past occurrence in a reservoir to prediction of future behaviour and consequences, analytical treatment, as given for other driving mechanisms, is required.

The application of fluid flow theory in porous media to steady and unsteady state pressure build-up in producing wells, which follows the closing-in of the wells, is lucidly but not critically discussed. Extension of the discussion to consider the effects of gravitational fluid-phase segregation within the bore-hole upon the build-up behaviour in cases where delivery to the well

is in the form of two-phase flow of vapour and liquid would have helped to clarify the limits within which the validity of the treatment is assured. For conditions where well productivity is small and the inplace producing gas-to-oil ratio is intermediate in value, early trend of pressure build-up may be influenced in greater degree by fluid segregation then by afterflow.

The volume contains much useful factual information in tabular and graphical form and the topics are discussed on a plane, which can be understood by students of the applied sciences and at the same time are founded on up-to-date methods of application. It should prove of great service to students and engineers, who wish to acquire a sound working knowledge in the practice of field reservoir engineering. The consistently practical attitude and the use of field engineering units constitute two of the several attractive features of this book. The indexes of authors and subjects are comprehensive and the bibliography, which accompanies each chapter, includes most of the significant contributions to date concerning the topics discussed therein.

Finally, the work is mainly a correlation and formulation of established principles and theories, much of which already has appeared in the literature in papers, books and articles, for the express purpose of practical application, and the authors are to be congratulated on a presentation at a level which, on the one hand, makes the subject matter easily intelligible to science students, and on the other hand, is directed to a particular class of readers with the requisite background of knowledge and experience in the disciplines involved.

H. GILMOUR

Continuous Creation and Extinction

Towards a Unified Cosmology. By REGINALD O. KAPP. *Hutchinson.* (35*s*)

Astronomy is an expanding science; during the last few decades our knowledge of the universe has increased out of all recognition. We have, moreover, made a start in the direct exploration of space. Vehicles have been sent away from our own world, and in 1959 the first probe landed upon the surface of the Moon.

Yet our Solar System is completely insignificant in the cosmos as a whole, and we must take care not to become parochial in our outlook. Only our nearest celestial neighbours are available for study in any detail, and it must be remembered that even the most distant stars of our own galaxy are comparatively close. Far away beyond the boundaries of the Milky Way lie the other galaxies, some of which are considerably larger than ours. Such is the Great Spiral in Andromeda, Messier 31, which lies approximately 2,000,000 light-years from us. We are now seeing it not as it is, but as it used to be long before true men appeared on earth. It is humbling to recollect, too, that Messier 31 is one of the nearest of the large galaxies.

Of all the problems facing modern science, those of cosmology are among the most fascinating. How did these vast systems come into being? Did all the material in the universe come into existence at one particular moment, or is there some other explanation? Does space go on for ever, or is it curved? And for that matter, how do the galaxies themselves develop?

According to theories which were accepted by nearly all scientists before the Second World War, the universe was created at one special moment of time. Cosmologists such as the Belgian abbé Lemaître postulated a "primæval atom," which exploded and sent its material flying outward in all directions. On this theory, or any modification of it, the universe will eventually die, and resembles a clock which is running down.

Very different from these "evolutionary" theories are the ideas put forward by Hoyle, Bondi, Gold and others. It is suggested that matter is being created out of nothingness, and that this process is going on all the time. Consequently, there was no beginning, and will be no end; the universe has always existed, and will exist for ever. Any particular stars and galaxies will, of course, die, but they will be replaced by fresh ones.

It is extremely difficult to decide between these two theories, but radio astronomy may be able to provide decisive evidence. On the continuous creation or steady-state theory, the universe in past ages must have looked much the same as it does now; on the evolutionary theory, conditions of distribution would be different. It seems as certain as anything can be that at present, the galaxies are receding from each other; and it is probable that such expansion of the universe has been going on for about 9,000 million years. Radio methods may, in the foreseeable future, allow us to study galaxies which lie at distances of this order, so that in effect we are looking through time as well as through space.

In this new book, Professor Kapp examines the various problems of cosmology, and puts forward many revolutionary theories. He points out that he suggested continuous creation —or, as he prefers to call it, continuous origin— of matter as long ago as 1940, thus anticipating Bondi and his colleagues by some years. But Professor Kapp goes further, and also postulates the continuous extinction of matter. On the criterion of what he calls "the Principle of Minimum Assumption", he states that "Any particle of matter or quantum of energy may have existed for any length of time . . . this is a way of saying that matter and energy are originating without cause, continously, at random, and not as a result of anything in the existing state of affairs. . . . Any particle of matter or quantum of energy may cease to exist at any time . . . matter and energy are disappearing without cause, continuously and by extinction, at random, and not as a result of anything in the existing state of affairs."

This extinction is linked with gravitation, which he regards as quantised; gravitation pulses are in fact emitted only when matter becomes extinct. Matter, then, has a "half-life", and it follows that any particular piece of matter will eventually disappear. Professor Kapp believes that the Earth itself is shrinking as its matter becomes extinct, and that the value of the gravitational constant g is becoming less, so that it has decreased appreciably even since the time of Newton. Appendix E, "The Shrinking Earth", will indeed sound strange to astronomers and to geophysicists. The hypothesis is invoked to explain such phenomena as the supposed Wegener continental drift, and even the disappearance of the great creatures of Mesozoic times. According to Professor Kapp, the Earth will eventually lose so much mass that its atmosphere will escape, and the final end of life on Earth is likely to be caused by lack of oxygen in the remaining air. He believes that Mars is already airless, which is not in accord with modern astronomical research.

Professor Kapp has put an immense amount of work into his book. Basing his ideas upon these revolutionary theories, he describes the evolution of the galaxies, the nature of space and what he terms "anti-space", and the extinction of space; he traces the past history of the solar system, and suggests that the body we know as the planet Jupiter represents the remains of an old star out of which the remaining members of the solar system were produced. Comets, for instance, are regarded by Professor Kapp as "degenerate remnants of larger chips thrown off Jupiter".

Enough has been said to show that Professor Kapp's theories differ widely from those of other scientists; but he himself is well aware of this, and has taken great pains to stress it.

PATRICK MOORE

High Performance Coolants

Liquid-Metal Heat Transfer Media. By S. S. KUTATELADZE, V. M. BORISHANSKII, I. I. NOVIKOV and O. S. FEDYNSKII. Supplement No. 2 of the Soviet Journal of Atomic Energy. *Consultants Bureau, New York; Chapman and Hall, London.* (180*s*)

Liquid metals are attractive as heat transfer media mainly because of their stability and low vapour pressure at relatively high temperatures. It is also true that their high thermal conductivity, when compared with non-metallic liquids, generally leads to higher heat-transfer coefficients; this difference is most marked at low flow rates, however, and tends to disappear at high Reynolds numbers when turbulence contributes greatly to the heat diffusion process.

Experimental data in this field has increased enormously in volume over the past ten years, mainly because of interest in the application of liquid metals to nuclear-reactor cooling, and whilst there are a number of interesting heat-transfer topics still to be investigated, the designer will find that the heat-transfer process as such is not one of his most serious problems. For example, it is possible when using sodium to achieve surface heat fluxes of 1 kW per sq. cm (3×10^4 Btu per sq. ft per hour) with temperature differences of about 100° C and modest flows (300 cm per sec in a 1 cm diameter pipe). At this heat flux the temperature gradient through stainless steel is about 500° C per mm, and the temperature drop across a pipe wall is consequently much more important than that from the wall to the sodium.

Given a reasonably accurate estimate of heat-transfer coefficients the designer will be much more concerned with handling techniques and with the compatibility of materials in liquid metals. It is in this respect that the *Liquid Metals Handbook* (United States Atomic Energy Commission, 1950) proved to be of such value to those interested in the early applications of liquid-metal coolants to nuclear reactors.

Scientists in the USSR have made a considerable contribution to liquid-metal heat-transfer data, and it is with the greatest interest that one receives a translation of the Russian counterpart to the *Liquid Metals Handbook*. As far as the design engineer is concerned, the justification for such a translation must depend rather heavily on the extent to which it assists him in solving handling and materials problems. The heat-transfer specialist, on the other hand, will look for an up-to-date review of experimental data and for a clear statement of theoretical models with which the data are compared.

The book is divided into 13 chapters, seven of which deal with heat-transfer data for specific problems such as forced convection in tubes, around flat plates, outside tubes and tube banks with natural convection, boiling and con-

Continued on next page

densation. The remaining chapters are concerned with physical properties, corrosion of constructional materials, handling techniques, instrumentation, and there is also a rather inadequate statement of the application of liquid metals to nuclear reactors and other industrial plant. By comparison with the *Liquid Metals Handbook*, much more experimental heat-transfer data are presented, and less space is devoted to liquid-metal handling techniques, chemical properties and industrial applications. The chapters on corrosion are similar; for example, the tabular summary giving the resistance of materials to a range of liquid metals is identical apart from changes in one or two names, such as mild steel, which have not survived translation into Russian and back into English!

The standard of translation is not uniformly good. The heat transfer expert will have little difficulty in understanding the changes in phraseology, but the general reader may well be baffled. For example, the "turbulent core" of fluid in a pipe is sometimes, but not always, referred to as the "turbulent nucleus"; and "nucleate" and "film" boiling become "bubbling" and "pellicular" boiling. Such irritations are bad enough if they merely impede the reader without misleading him; however, in at least one case, a reference to a paper (written originally in English) appears, after translation into Russian and back into English, in a quite incomprehensible form.

To summarise, we have a translation of the Russian "Liquid Metals Handbook," some of which was based on the original American *Liquid Metals Handbook*. There is a greater volume of heat-transfer experimental data in the Russian version, but less information on handling techniques. The differences are not great, and even if the translation were perfect, it is doubtful whether the design engineer would find it more useful than the original American *Liquid Metals Handbook* together with the "Sodium Supplement" to that handbook. The translation, however, is by no means perfect, and therefore it cannot be recommended to the design engineer or to the general reader. The heat-transfer specialist will find more to interest him, but may prefer to read the original papers, where translations of these are available, instead of a rather condensed review. In the writer's opinion the review is not particularly penetrating, and in the field of forced convection is inferior to some which have appeared during recent years (e.g. Kaufman and Lubarsky, NACA Report No. 1270). Nevertheless, it provides a useful reference to the considerable volume of data in this field which has been produced in the USSR in recent years.

There is no index, but an adequate bibliography is provided.

W. B. HALL

New Books

Atomic Theory for Students of Metallurgy. By WILLIAM HUME-ROTHERY. 3rd edition. Institute of Metals Monograph and Report Series No. 3. *Institute of Metals, 17 Belgrave Square, London, SW1.* (50*s*)

The electron theory of metals involves a general background of atomic theory with which the metallurgical student is often unfamiliar. The present book is written primarily to provide a bridge to an understanding of the ideas underlying the new theories.

Woods Practical Guide to Fan Engineering. Edited by W. C. OSBORNE and C. G. TURNER. 2nd edition. *Woods of Colchester Ltd., Colchester, Essex.* (17*s* 6*d*)

A comprehensive reference book on fan engineering for ventilation, air cleaning, cooling, drying, and heating. The new edition introduces sections on drying and air heating, the isolation of vibration, and a new approach to sound level assessment by means of octave band analysis.

Direct Conversion of Heat to Electricity. Edited by JOSEPH KAYE and JOHN A. WELSH. *Wiley, New York; Chapman and Hall, London.* (70*s*)

An edited collection of papers on work in the various fields of direct energy conversion, divided into the general areas of thermionic engines (high vacuum and low pressure), magnetohydrodynamic converters, semiconductor devices, and fuel cells.

Symposium on Hydraulic Fluids, October 1959. ASTM Special Technical Publication, No. 267. *American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.* ($3·75)

Papers at the symposium were divided into two groups: the first on problems and trends in use, the second on developments and evaluation methods. The second section includes a review of new developments in high-performance fluids for military aircraft and industrial applications.

Nuclear Radiation Measurement. By J. SHARPE. Nuclear Engineering Monographs. *Temple Press.* (12*s* 6*d*)

Attention has been concentrated in this monograph on the basic physical operation of nuclear radiation detectors, with one chapter given over to a short survey of the associated electronics equipment necessary for efficient operation.

Statistics Manual. By EDWIN L. CROW, FRANCES A. DAVIS, and MARGARET W. MAXFIELD. *Dover Publications, New York; Constable, London.* (12*s* 6*d*)

The manual was prepared by the US Naval Ordnance Test Station for Defense Department use, with examples taken from cases of ordnance development, but it has applications for engineers and scientists generally who wish to use statistical procedures to improve the efficiency of their experiments.

Génie Chimique. Volume 1: Mécanique des Fluides. By RENÉ GIBERT. *Editions Eyrolles, 61 bould. St-Germain, Paris, 5.* (27·40 *NFrs*)

The first section of the chemical engineering syllabus of the Ecole Nationale Superieure des Industries Chimiques at Nancy is concerned with fluid mechanics, aimed at fitting the chemical engineer to tackle both routine running problems and those encountered in design and development.

British Plastics Year Book, 1960. 30th edition. *Iliffe.* (42*s*)

Nearly 7,000 firms associated with plastics are listed in the directory section, some 4,000 of them overseas. Classified lists of manufacturers and suppliers of materials, equipment and finished products are supplemented by a valuable list of annotated trade names.

The Reviewers

Mr. J. R. Hall, B.Sc., A.R.S.M., joined Johnsson Matthey and Company in 1951 and served with them for the next five years. Since then he has been connected more generally with the non-ferrous metal industries.

Dr. H. Gilmour is senior lecturer-in-charge in the department of petroleum production engineering at the University of Birmingham. He is a fellow of the Institute of Petroleum and has published several papers and articles on subjects connected with petroleum production engineering.

Mr. Patrick Moore is best known for his television broadcasts on astronomy. An amateur astronomer himself, he carries out observations of the Moon and planets. He is a Fellow of the Royal Astronomical Society, is director of the Mercury and Venus Section of the British Astronomical Association, and was secretary of the Lunar Section from 1945 to 1956. He is also a member of many foreign societies. Writer of many books on astronomy and kindred subjects, he is the joint author of what is probably the best documented study of the Moon.

Professor W. B. Hall, B.Sc. (Eng.), A.M.I.Mech.E., occupies the chair of nuclear engineering at the University of Manchester. Until October 1959, he was deputy chief scientific officer in the research and development laboratories of the United Kingdom Atomic Energy Authority laboratories at Windscale, working on heat transfer and fluid mechanics.

Trade Publications

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Materials

Aluminium Floors for Fishrooms. IMPERIAL ALUMINIUM COMPANY LTD., Great Charles Street, Birmingham 3. Aluminium alloy extrusions and boards for trawler fishrooms. Data sufficient for preliminary design. People who have used such materials. 8 pp., ill.

Bright Copper Plating. W. CANNING AND COMPANY LTD., Great Hampton Street, Birmingham 18. Details of Cuprobrite plating baths, introductory. 2 pp, ill.

Silicone Fluids and Greases. MIDLAND SILICONES LTD., 68 Knightsbridge, London, SW1. Well informed introduction to the materials. Properties and applications. 8 pp., ill.

Titanium. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Weight tables for the company's wrought titanium products. 12 pp., ill.

Hydraulic Oils. WAKEFIELD-DICK INDUSTRIAL OILS LTD., Marylebone Road, London, NW1. Design, installation, operation and maintenance of hydraulic equipment. Chapters on fundamentals of hydraulics. 74 pp., ill.

Asbestos Cement. UAM GROUP ADVISORY SERVICE, Watford, Herts. Fifth catalogue in a series. Magnum sheets, with bold profile, suitable for roofs and walls of large industrial buildings. 21 sheets, ill.

Tool Steels. CLIMAX MOLYBDENUM CO. OF EUROPE LTD., Cavendish Place, London, W1. Commissioned in America by parent company. General article on tool steels, mostly containing molybdenum. 32 pp., ill.

Solvent Recovery. CHEMICAL ENGINEERING WILTONS LTD., Cheadle Heath, Stockport. General outline of process which uses Supersorbon activated carbon. 2 pp., ill.

Town's Gas. SIMON-CARVES LTD., Cheadle Heath, Stockport. General outline of process. Catalytic reforming of hydrocarbons (mainly oils) in continuous Otto process. 5 pp., ill.

Fuel Oils. MOBIL OIL CO. LTD., Caxton House, Westminster, London, SW1. Factors connected with choice and use of fuel oils in heating appliances. Written in conjunction with Charrington, Gardner, Locket (London), and Associated Coal and Wharf Companies. Three booklets: *Use and Storage of Fuel Oils*, 20 pp., ill; *Steam and Hot-Water Boiler testing*, 20 pp., ill; *Fuel-Oil Analysis*, 20 pp., ill.

Copper. COPPER DEVELOPMENT ASSOCIATION, South Audley Street, London, W.1 Introductory guide to grades, properties and applications (not alloys). Eighteenth revised edition of *Copper Data*, 78 pp., ill.

Rust Prevention. EXPANDITE LTD., Chase Road, London, NW10. Introduces Metalgalv, Expaflex and Gewi tape. 3pp., ill.

"New" Metals. IMPERIAL CHEMICAL INDUSTRIES LTD., Millbank, London, SW1. Readable survey of manufacture, properties, and applications of titanium, beryllium, zirconium with mentions of hafnium, niobium and vanadium. 18 pp., ill.

Chlorination. WALLACE AND TIERNAN LTD., Power Road, London W4. Three publications cover V-Notch control equipment, residual chlorine controller, and recorder. 16 pp., ill.; 6 pp., ill.; and 6 pp., ill., respectively.

Radiant Tubes. INCANDESCENT HEAT CO. LTD., Smethwick, Birmingham. Brief indication that gas fired Jetubes are now used in vitreous enamelling, including new L-shaped tubes. 3 pp., ill.

Marketing

A Very Small Foot in the Door

THE increased quota for Japanese transistor radio exports to the United Kingdom will bring the annual import into this country of these tiny sets from Japan to £200,000, in place of the old rate of £112,000 a year.

The concern of the British radio industry is naturally not based on the home impact of an import into the home market of sets worth a fifth of a million pounds, but on the highly valid point that a quota which can be almost doubled one year may at some time be doubled again. And multiples of even £200,000 can become significant quite swiftly.

The Japanese export of transistor sets worth £20 million to the United States last year is an indication of the sort of penetration that is possible.

Major New Mill for Brazilian Steel

Electric drives, motors and controls worth $22 million are to be supplied for a new integrated steel mill at Piacaguera, Brazil, by the WESTINGHOUSE ELECTRIC INTERNATIONAL Company of the USA.

The mill is at first to produce 600,000 tons of sheets and plates a year when rolling equipment is installed in 1962. By 1967 it is expected that the mill will be up to full capacity and producing 2·5 million tons of finished products a year.

The annual use of steel in Brazil is expected to be about half a million tons above the home producing capacity even when the Piacaguera mill is in full production in 1967.

The COMPANHIA SIDERURGICA PAULISTA (COSIPA) are constructing the mill. The main drive motors will have a total rating of 50,600 h.p. Six rolling mills, three process lines and a blast furnace will all use Westinghouse electrical equipment.

The rolling equipment will be installed first, instead of the practice of putting in the steelmaking plant at the start. This will enable the mill to process semi-finished steel from another important Brazilian mill, COMPANHIA SIDERURGICA NACIONAL. Once the COSIPA mill is complete it will process raw material from an " iron mountain " in a neighbouring state.

Varied New Orders for David Brown Construction

£250,000 worth of orders, almost entirely for export, have been placed in the last few weeks with DAVID BROWN CONSTRUCTION EQUIPMENT of Meltham, Huddersfield, Yorkshire. The larger part of the total value is in industrial wheeled and crawler tractors plus their ancillary equipment and spares. There is also a substantial order for marine diesel engines.

The equipment will go as far afield as Canada, Poland, India, Chile, West and North Africa and New Zealand.

The Polish order is for ditchers made by BARFORD (AGRICULTURAL) incorporating David Brown 30TD crawler chassis. One hundred David Brown marine diesel engines will go to HARRY WALKER Limited, the Vancouver, Canada, boat building firm. They are mostly intended for fishing boats and small commercial craft.

One of the Indian orders will result in the company's aircraft-towing tractors appearing on the flight deck of the former HMS Hercules, now a carrier with the Indian navy as INS Vikrant. The Indian Air Force have also ordered a number of the towing tractors. An Indian power station is to use two 50TD crawler tractors, fitted with special U-blades, for use in stockpile control.

Management Selection in Australia

MANAGEMENT SELECTION Limited, consultants in executive appointments, have now established a formal link with the Australian company, MANAGEMENT SELECTION AUSTRALIA Pty.

The MSL chairman, Sir Walter Puckey, recently visited Australia and was impressed by the great promise of development there. The stronger association between the two companies should, in Sir Walter's view, be particularly helpful to United Kingdom firms established in Australia or thinking of setting up there.

Sir Alexander Fitzgerald, chairman of the Commonwealth Grants Commission, has been appointed chairman of the Australian company.

EMI Outside TV Unit for Hungary

The HUNGARIAN BROADCASTING AUTHORITY have bought an Outside Broadcasting Television unit produced by ELECTRIC AND MUSICAL INDUSTRIES ELECTRONICS Limited.

The unit has four of the most recent EMI Image Orthicon Cameras and a zoom lens. It can be used as a studio control room, being equipped with remote facilities and a new relay switching technique.

M.V. Bardic Ferry, a drive-on drive-off vehicle ferry carried the unit, which is mounted on a seven ton chassis, from Tilbury to Antwerp. For the road journey to Budapest the unit was mounted on a low loading trailer by G. C. MUNTON, acting together with EUROPEAN TRANSIT Limited.

Polaris Electronic Contracts for Northrop

Contracts worth £10 million ($28 million) have been awarded by the United States Navy for the design, development and production of electronic equipment, gyroscopes and other components for the Polaris fleet ballistic missile system.

The work is to be done by the NORTHROP CORPORATION, a division of the American Northrop International.

Design and production, which also covers periscopes and radiometric sextants, will be carried out at the Nortronics division plant, Anaheim, California, and at the Nortronics precision products department, Norwood, Massachusetts.

Northrop have provided the automatic checkout equipment for the Polaris since early last year. Equipment is being installed on the US Navy's missile-firing submarines, tenders and at the naval weapons station, Charleston, South Carolina.

The special Datico system monitors, checks out and carries through the launching count down sequence for the 16 Polaris missiles carried on each submarine. The company state that instalations are complete on the USS George Washington and on other nuclear submarines.

Boulton Paul Win Steel Handling Orders

An automatic handling plant for structural steelwork is to be manufactured for an Australian firm by BOULTON AND PAUL, of Norwich. It is the first contract of its kind for the company in Australia.

The users of the plant in Australia will be JOHNS AND WAYGOOD, of South Melbourne, a long established structural engineering firm who were the pioneers of iron and steel buildings in the city. They are now one of Australia's largest engineering concerns.

The automatic handling plant, worth £90,000, is made up of mechanised sawing and drilling machines connected by conveyor equipment.

In order to increase their own structural steelwork output Boulton and Paul are installing the largest mechanised fabricating plant in Britain at the London works of their subsidiary, MORELAND HAYNE & Company. The company's steel fabricating plants use machines and equipment by JAMES ARCHDALE, of Worcester, LAURENCE, SCOTT AND ELECTROMOTORS, of Norwich and Manchester, and CLIFTON AND BAIRD, of Glasgow.

The Australian order comes soon after the dispatch of the largest type of mechanised steel fabricating plant in the world to YUBA ERECTORS, of San Francisco, a division of the US firm, YUBA CONSOLIDATED INDUSTRIES. This was worth about £114,000.

Senior Boulton and Paul staff are going to the United States in connection with the erection of the Yuba plant and to cope with the amount of interest in Norwich-made mechanical handling plants.

Untimely Decree for rench Shipbuilders

Has the French Government, in taking legal action towards the concentration of the shipbuilding industry, appeared on the scene at the wrong time, and perhaps even in the wrong play?

In future, using the 1951 law which gave the right to subsidies for all building alteration or repair of ships above 50 gross tons, the Government is to announce each year which yards will receive an allocation and how many francs they are to be given. It is made plain that the authorities will use this power to bring about specialisation and to move towards the concentration of the industry.

Some recent figures of shipbuilding orders, and the widely held view that the bottom of the shipping slump has been plumbed, suggest that the French official action is not necessarily the most likely to encourage the industry. An official inquiry, of which results were published just before the Government announcement, came up with an estimate that from 1962 the French shipyards would have a yearly capacity of 700,000 gross tons and that their deliveries would be of the order of 400,000.

It is this estimate which appears to be quite possibly wrong. And if it is there may be advantages to be gained from French shipyards retaining their ability to meet the wider needs of a range of customers—if the customers are forthcoming.

And the current order figures suggest that they may be. While the 400,000 gross tons order in 1955 had sunk progressively to 45,000 in 1958, the orders for 1959 rose again to 300,000 and this year the first four months added 140,000 tons ordered—an annual rate, not allowing for the suggested acceleration, of 420,000 tons.

New Zealand Ferry Contract for Denny

The WILLIAM DENNY shipbuilding firm is to build the new ferryboat for the Cook Strait Railway Ferry between the North and South islands of New Zealand.

The cost of the new ferry will be about £1,800,000. It is expected to be in Wellington by May 1962.

Towards Common European Engineering Standards

British industry must play an active part in steps towards the alignment of Western European electrical engineering Standards. This is the policy statement recently declared by the Council of the BRITISH ELECTRICAL AND ALLIED MANUFACTURERS' ASSOCIATION.

BEAMA point out that over the past two years the European Economic Community has been working towards common standards for the signatories of the Treaty of Rome. The six Common Market nations have said that they were willing to extend this cooperative effort so that the EEC States and the seven-member European Free Trade Association countries would, in future, collaborate on an equal footing.

The way is now open for the 13 countries to work as partners towards the alignment of Western European Standards and the maximum development of international Standards through the International Standards Organisation (ISO), the International Electro-Technical Commission (IEC), and the International Commission on Rules for the Approval of Electrical Equipment (CEE).

The policy statement reads: "The BEAMA Council considers it essential that the United Kingdom should play an active part in such developments and strongly supports any such efforts towards a greater degree of harmonisation in international standards and practices than has existed previously."

New $4 Million Process for Aluminium Production

At a cost of $4 million (£1·4 million) ALUMINIUM Limited are to build works at Arvida, in Quebec, Canada, for the production of aluminium by what is described as a fundamentally new process.

The president of Aluminium Limited, Mr. N. V. Davis, and the president of ALUMINIUM LABORATORIES Limited, Mr. H. H. Richardson, have stated that the new capacity is expected to be ready for use in two years.

No Life for a Barnacle on Windsor Castle

Almost as important to a ship as the prevention of corrosion is the removal of fouling. A new anti-fouling system which has given impressive results has been fitted to Britain's newest luxury liner to give her longer periods between dry-docking.

THE Union Castle Line's new flagship, the 38,000 ton RMS Windsor Castle, was due to start her maiden voyage in the South African Mail Service from Southampton yesterday. Fig. 1 shows her pleasing lines, and though she is conventional in appearance she is noteworthy in several respects. For instance, she is the largest vessel yet built on the Merseyside and will be the largest vessel regularly employed in the South African trade. When she was launched by Cammell Laird and Company Limited at Birkenhead she was the largest vessel built in the UK since the Queen Elizabeth. From the point of view of her passengers and crew she is an improvement on her sisters in that she is fitted with air-conditioning practically throughout, and the first class cabins are all arranged with a porthole on one full side.

To the engineer the most significant feature is probably the fitting of Toxion anti-fouling equipment, devised and produced by F. A. Hughes and Company Limited, 4 Stanhope Gate, London, W1. Over the past two years this has been thoroughly proved in service, and though now provided on several vessels the Windsor Castle is the largest, and also the first British passenger liner so fitted. The Toxion system should not be confused with the same firm's Guardion cathodic anti-corrosion protection, although it has been found that Toxion protection is most effective when fitted in conjunction with Guardion, as is the case with Windsor Castle.

Initial experiments to assess the feasibility of the seemingly obvious course of incorporating anti-fouling protection with cathodic protection proved that this is not really practicable. The conclusion was reached that the only sure method is to kill rather than discourage the fouling organisms, by the discharge of poison under water. This is, of course, the action of the anti-fouling paint generally employed on ship's hulls below the waterline, in which the poison slowly leaches out. The Toxion system, however, in which the poison is emitted through tubes running along either side of the hull, shows several advantages over the paint method:

(1) Anti-fouling paint eventually loses its effect, then fouling will occur until the vessel is dry-docked, scraped and repainted. Using the Toxion system the hull can be kept free indefinitely, hence the periods between dry-docking can be extended right up to the permissible limit (MOT allow 12 months for Cl 1 passenger ships).

(2) The cost of anti-fouling paint and its application is eliminated.

Fig. 1 Windsor Castle at full speed during trials.

Technical details of Windsor Castle

Length overall	783 ft 3 in
Length b.p.	730 ft
Breadth moulded	92 ft
Depth moulded	50 ft
Maximum draught	32 ft
Gross tonnage	38,000
First class passengers	191 or 241
Tourist class passengers	691 or 591
Crew	475
Service speed	22½ knots
Max speed on trials	24·8 knots
Shaft horsepower	45,000

Propulsion:—twin screw, d.r. geared turbines of PAMETRADA design. 3 Babcock and Wilcox selectable superheat boilers, delivering 130,000 lb/hr of steam at 600 lb per sq. in and 950° F

(3) The cost of cleaning and scraping is very greatly reduced.

(4) With cathodic corrosion protection as well as Toxion, the hull paint can be chosen purely for durability and surface smoothness, virtually eliminating the attendant expenses of descaling and corrosion repairs

(5) Ship earning time is increased due to less time spent in dry dock.

(6) Maintenance of a smooth hull surface results in reduction of fuel consumption. Tests carried out by both the National Council of American Shipbuilders and the Port Line indicated that after 200 days out of dry dock the average ship requires a power increase of 24 per

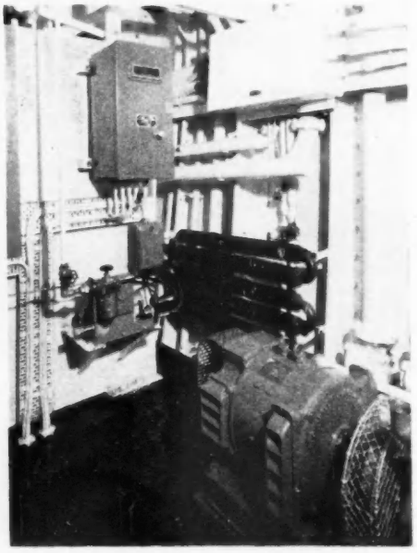
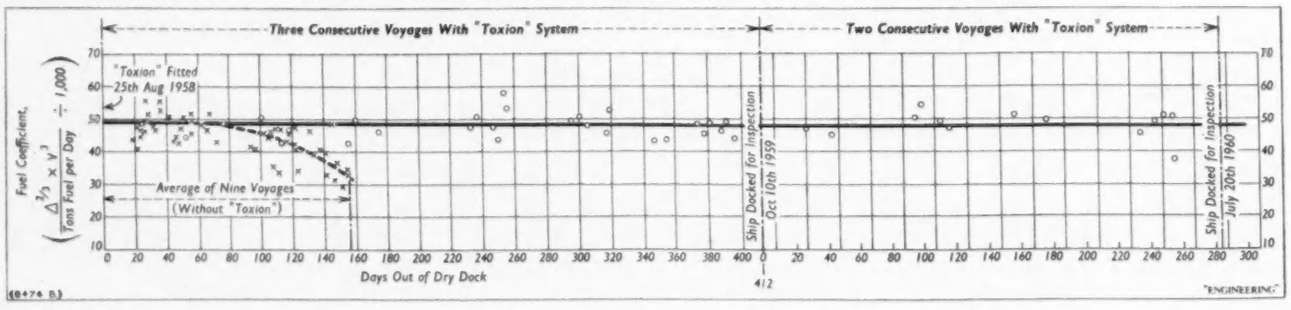


Fig. 3 Typical Toxion installation, showing the compressor, cooling coils, micro pump and starters. The control panel is just out of the picture to the left.

Fig. 2 SS Ballarat, graph of fuel coefficient plotted against time out of dry dock before and after fitting anti-fouling equipment.


Three Consecutive Voyages With "Toxion" System
Two Consecutive Voyages With "Toxion" System
"Toxion" Fitted 25th Aug 1958
Average of Nine Voyages (Without "Toxion")
Ship Docked for Inspection Oct 10th 1959
Ship Docked for Inspection July 20th 1960
Fuel Coefficient, (Δ^2/3 × V^3 / Tons Fuel per Day) ÷ 1,000
Days Out of Dry Dock
(80474 B)
"ENGINEERING"

cent to maintain speed, due to fouling and roughening of the hull.

The saving of operating costs in a ship of the size of Windsor Castle can be very readily appreciated.

The P. and O. Line's SS Ballarat, an 8,800 ton cargo vessel, provided the first opportunity of studying the direct effects of the Toxion system. She plies between the UK and Australia and was originally fitted with cathodic anti-corrosion equipment alone, with anti-fouling paint on the hull. In this condition she had to be dry-docked every five months or so for repairs. In August, 1958, Toxion equipment was fitted, still retaining the cathodic protection but with the anti-fouling composition sealed off. On the same run, it was 14 months before any attention was required on the hull, and then it consisted merely of brushing off a small amount of dead growth and a little light scraping. She was last docked a month ago with even better results. To give an indication of the consistently smooth surface of the hull, Fig. 2 is a graph of the Ballarat's fuel coefficient plotted against the number of days out of dry dock. It will be noted that the increase in fuel consumption over the whole period is negligible, and the dotted curve indicating average results before fitting Toxion is included for comparative purposes.

Windsor Castle's Guardion cathodic protection uses sacrificial galvanic anodes. The Toxion system is shown diagrammatically in Fig. 4, together with the Guardion anodes (1). Two large service tanks (2) (for operation and reserve), mounted slightly above the rest of the equipment, contain kerosine mixed with concentrated Toxion fluid. The kerosine acts as a vehicle for the poison, being cheap, non-persistent and insoluble in sea water.

From these tanks, the diluted poison is metered through a micro pump (3) to an injection unit. Here it enters a stream of cold compressed air supplied from a compressor (4) and fed to the injection unit through cooling coils (5). Feed pipes (6) carry the mixture via shut-off valves (7) and dispersal pads welded on the hull to small-bore dispersal tubes (8). These are fitted in selected positions along the hull in relation to the keel and bilge keel, and incorporating a series of small discharge orifices. For safety reasons the feed pipes must be carried to a point in the ship well above the water line before the final downward run. The starters (9) enable the system to be started manually, and this is generally done when the telegraph reads Stand by, on entering harbour. There is normally no need to run the system except in port or at anchor, since the fouling organisms only appear to be able to attach when the speed is less than two knots.

The control panel (10) monitors the discharge rates and incorporates compensating valves to give a balanced release of poison from the various orifices. Visual compressed air flow indicators are fitted. Accidental discharge of the poison is prevented by electrically interlocking the pump with the compressor, but the latter can be operated separately to prevent the orifices from silting up.

The dispersal tubes themselves are made of high impact plastic carried in U-shaped steel shrouds intermittent welded to the shell plating at the base of the U. Fig. 5 shows this piping and one of the dispersal pads in course of attachment to the outside of a ship's hull. The orifices in the dispersal tubes are variably spaced and the method of release causes formation of minute air bubbles enveloped in the fluid. These bubbles, in rising and collapsing against the shell plating, distribute a micro film of poison over the hull, where distribution and adherence are assisted by the chemical properties of the poison in association with the polarised hull obtained by the cathodic protection equipment.

Toxion liquid is lethal to all forms of marine organisms and vegetable life. Unlike many poisons, it cannot accumulate or pollute closed waters due to the high degree of adherence to the hull, but even should the poison accidentally be freely released it quickly becomes harmless.

Very little space is required within a ship for anti-fouling equipment. Fig. 3 shows the installation in the Athelprincess, a 10,000 tons bulk sugar carrier owned by Athel Lines Limited of London, which shows how the arrangement is tailor-made to suit the available space.

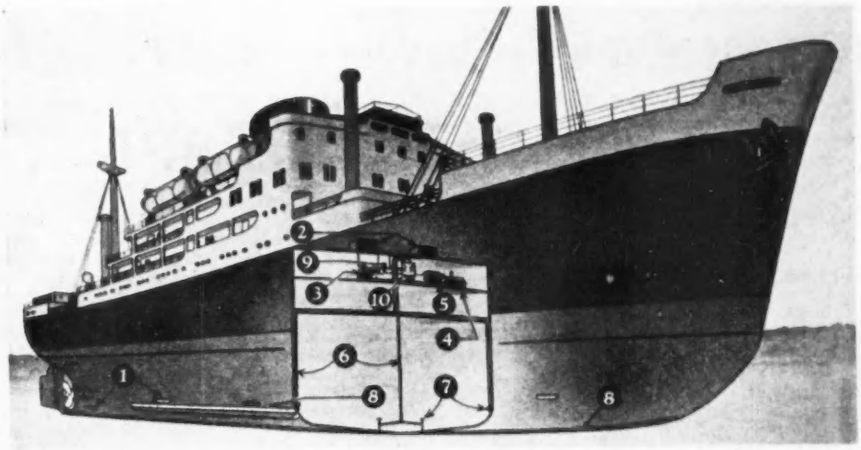


Fig. 4 Typical diagrammatic arrangement of Toxion system in conjunction with Guardion cathodic protection.

1 Guardion anodes
2 Toxion tanks
3 Micro pump
4 Air compressor
5 Cooling coils
6 Feed pipes
7 Isolating valves
8 Dispersal tubes
9 Starters
10 Control panel

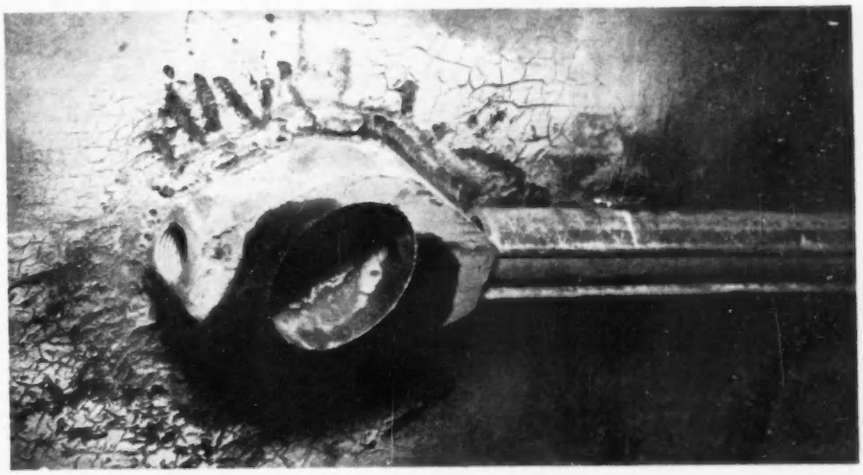


Fig. 5 Attachment of dispersal pad and shrouded tubes to a ship's hull. Before refloating, a plate will be welded over the open end of the pad.

New Light 4 Cwt Threewheeler Economy Van

The well known Bond Minicar now has a commercial vehicle counterpart, the Bond Ranger. It is claimed that the Ranger will cover 80 to 85 miles per gallon, and that the total running costs for the first 20,000 miles work out at less than a penny per mile, including petroil, tax and insurance. The new van is, in fact, intended primarily for town delivery work by the small operator.

The Ranger has a load capacity of 31 cu. ft plus the driver. Goods can be loaded either through the lift-up rear window, which is of toughened Triplex glass, or through the nearside front door. The bodywork is hand made in light alloy on the stressed skin principle, with a glass fibre hard top. The Ranger sells for £295 in primer, plus £4 10*s* for painting in a standard colour.

The 250 c.c. Villiers Mark 31A/4 Siba single cylinder two-stroke engine gives the Ranger a cruising speed of 45 m.p.h. and a top speed of 55 m.p.h. No provision for reversing is made in the 4-speed gearbox, but an engine reversing mechanism can be fitted as an optional extra. The engine and gearbox are unit mounted with the front wheel, which has a lock-to-lock movement of 180°, i.e., 90° either side of the straight ahead position. This gives maximum possible manoeuvrability in confined spaces and it is claimed that the Ranger can get in or out of a parking space only 2 in greater than its own length.

Other features are fully independent suspension front and rear electric self starter and sprung steering wheel. Overall length of the Ranger is 11 ft, width 5 ft, height 5 ft, ground clearance 7 in and unladen weight 672 lb. Accelerator, clutch and footbrake are operated by pedals as in a normal car, while the gear change lever is mounted on the dashboard. A 12-volt electrical system is used, with coil ignition, automatic voltage control and ignition warning, and charge indicator on the dashboard.

The Ranger is made by Sharps Commercials Limited, Ribbleton Lane, Preston, Lancashire.

Bigger Engine, Brakes and Wheels for Velox and Cresta

A new 2·6 litre six-cylinder engine developing 113 b.h.p. (gross), powers the 1961 Vauxhall Velox and Cresta models. With it come a higher axle ratio (3·9 instead of 4·11 to 1) and larger wheels (14 in diameter instead of 13). To handle the increased power the clutch has been increased to 9 in diameter and brakes are more powerful, with 10 in diameter drums at the front raising total lining area to 147 sq. in. Front springs are stronger and the forward underbody structure is stiffer.

There are several minor styling changes. Interior improvements include a new instrument panel with ribbon-type speedometer.

The new power unit is " square " with bore and stroke of 82·55 mm giving 2,651 c.c., an increase of 17 per cent. Compression ratio is raised to 8·1 to 1 (from 7·8). Gross output is 113 b.h.p. at 4,800 r.p.m. (94·6 b.h.p. installed at 4,600 r.p.m.) and max gross torque is 148 lb-ft at 2,400 r.p.m. or 138·5 lb-ft installed at 1,600 r.p.m.

There is a torque of at least 130 lb-ft gross available all the way from 1,100 to 4,500 r.p.m. which is more than the peak torque given by the old unit.

The forged steel crankshaft runs in four bearings and has an overlap of $\frac{1}{16}$ in between main and big-end journals. The pushrod-operated overhead valves lie in separate smooth-finished ports and are of composite construction with wear resistant stems welded to heat and corrosion resistant heads. The heads are forged in austenitic steel and the stems are in low-alloy SAE 8645 steel. The combustion chambers are wedge-shaped. Pistons are tin-plated, with offset piston pins and chromium plated top rings. The crankcase is ventilated with filtered air and vented to the carburettor air cleaner. There is a coolant distribution duct inside the water jacket.

Ratios in the three-speed all-synchromesh gearbox are unchanged, but the new axle ratio raises the speed at 1,000 r.p.m. in top gear to 18·7 m.p.h.

Front brakes are now 10 in diameter increasing total lining areas to 147 sq in. Headlamps

on home market cars are a new sealed beam type, the first time sealed beams have been used in Britain. Velox rear lamps are redesigned in a smaller casing and the rear bumper is new.

Instrument panel in a hooded cluster in front of the driver, features a ribbon-type speedometer indicating first in green, then in amber and finally in red above 60 m.p.h. Upper part of the panel has a resilient " Royalite " covering. External changes include new side mouldings and name plates and new anodised aluminium wheel discs for Cresta. Car weight is increased by about 50 lb.

Vauxhall Victor for 1961

On the Victor most important external change is the new deeper rear window which has an area 18 per cent larger than on previous models. As the window now sweeps right up to the roofline the rear-view mirror (wider and deeper than before) has been mounted higher, so that it does not interfere with forward vision. The chromium ornament linking rear and side windows has been eliminated.

1961 models have new radiator grille, with the Vauxhall medallion in the centre, like that of the recently introduced Envoy but with more horizontal bars. On all models except the Victor Standard the headlamp cowls now have chromium-plated cappings.

Changes at the rear include a new turn-button lock built into the name plate; the trunk can now be fastened without being locked. The fluted chromium moulding along the side is heavier and the wheel nave plates are of new design. There is a full-circle horn ring on De Luxe, Super and Estate Car, and new instrument panel and instrument layout on all models. The speedometer needle travels a $7\frac{1}{4}$ in over arc.

Heater and ventilator controls, moving in a vertical plane, are now located at the driver's side of the panel. The estate car now has a felt mat with pvc plastic over the floor of the rear compartment, held in place by plated rubbing strips. New steel-shell big-end bearings of high

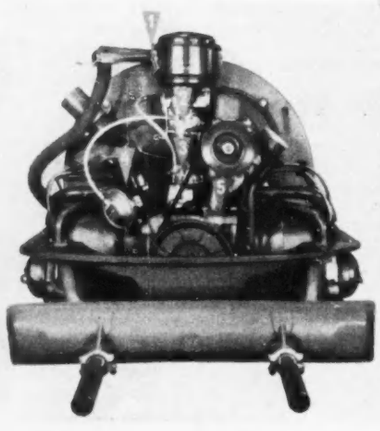
load capacity figure in the 1961 engine for greater resistance in motorway driving.

Volkswagen has New Engine and Gearbox

Many improvements reinforce the evergreen appeal of the Volkswagen for 1961. Foremost come the new, more powerful engine and four-speed all-synchromesh gearbox derived from the specially strengthened units fitted in Transporter and trunk versions for the past year or so.

By raising compression from 6·6 to 7·0 to 1, fitting larger valves with stronger valve springs and higher lift, a new camshaft and rotating cam followers, engine power has been increased by 4 b.h.p. to 40 b.h.p. (SAE) at 3,900 r.p.m. (formerly 36 b.h.p. at 3,700 r.p.m.) and maximum torque is now 61 lb-ft instead of 56 lb-ft at 2,000 r.p.m. Valve clearance is increased to 0·008 in and special expansion studs securing the rocker shafts to the cylinder heads minimise clearance changes due to thermal expansion. The carburettor has an automatic choke, and a counterweighted flap valve in the air intake feeds it with warm air from the cylinder ducts at low throttle openings to prevent ice formation in humid conditions. Vacuum spark control is now fitted to the distributor. To cope with the extra power the crankcase and crankshaft are more robust, bearing diameters are increased and the cylinders are spaced 0·4 in further apart to permit more effective cooling.

The re-designed VW engine developing 40 b.h.p.



The redesigned transmission comprises four speed gears—helical, constant mesh, with synchromesh for all forward speeds—in a new one-piece magnesium die-cast casing (previously it was split longitudinally). A new spring washer limits end float to ensure silent running. Overall gear ratios are now lower than before, changes being made in gearbox and final drive to give better acceleration and hill climbing.

	New	Formerly
1st gear	16·63 to 1	15·94 to 1
2nd gear	9·01	8·60
3rd	5·77	5·39
4th	3·89	3·64
Reverse	16·99	20·50

Acceleration from 0 to 50 m.p.h. is said to be possible in 10 sec against 31 sec previously. Maximum speed has risen to 72 m.p.h. and maximum gradient climable at steady speed in top is now 1 in 13·4.

Despite higher performance, Volkswagen claim lower fuel consumption at moderate cruising speeds and premium grade fuel is still unnecessary.

Numerous changes improve comfort, convenience and safety. A new transmission mounting reduces vibration and longer rubber bump stops make rear suspension more progressive. Redesign of the fuel tank has nearly doubled front luggage space and the tank is now vented to outer air, not to the luggage compartment. Semaphore indicators have been replaced by the flashing type. A padded visor and flexible grab handle are provided for front passenger and twin-jet windscreen washer is now standard. The new brake fluid reservoir is transparent plastic. Headlamps have an asymmetrical dipped beam for better anti-dazzle range and the dipper switch is moved slightly to prevent it being worked accidentally when declutching. As the engine now runs more quietly, a relay prevents the starter being operated while the engine is already running. Electrical wiring now has tab connectors and all fuses are accessible from inside the car. Door locks are improved and coat hooks are made of synthetic material for safety. Sill panel covers, wing beadings, steering wheel and mats harmonise with external finishes. Despite these improvements, prices are unchanged.

Most of these changes also apply to Karmann Ghia models which now have a maximum of about 75 m.p.h.

Water Flow Analogues for Gas Dynamics

By using water models, with tracer particles in the water, dynamic gas flow patterns may be simulated. Considerable information can be obtained quickly, and at low cost, by such methods.

By R. E. Morris, M.Sc., A.M.I.Mech.E., and B. Haythornthwaite

D. Napier and Sons Limited

EXPERIMENTAL work in gas dynamics usually involves the measurement of pressures and direction of flow at a number of points, to provide evidence for constructing a picture of the flow pattern. By this method a more or less complete picture may be obtained in accordance with the amount of time and money available for the work, but the amount of detail required is often so great that the ability to make correct deductions from incomplete observations becomes an essential part of the art of designing fluid machinery.

In many cases the problem may be simplified or clarified if there is some visual evidence of the flow pattern. Analogues which provide such visualisation are used freely in the Napier Research Station as an economical and rapid development method in a variety of aerodynamic problems.

These analogues have been used extensively in cascade and ducting development and has proved of particular value in studying the complex flow patterns inside combustion chambers. Their particular advantages are the speed and economy with which modifications can be carried out, and in the case of especially complex flows it may provide the only practical method of investigation.

The most convenient method of flow visualisation is by tracer particles in water. Basically, similarity of flow between gas and water is achieved by operating at the same Reynolds number although wide variations cause no significant change in flow pattern if the actual values are high and the flow is turbulent. The use of a liquid as the working fluid because of the increased density, results in conditions of flow similarity being attained at velocities much lower than those of the corresponding gas flow. Thus the dwell of tracer particles in the field of vision is increased, and transient flow phenomena take place over longer periods of time. In addition, the power requirements of the test equipment are usually much less than those for a comparable gas flow test.

The simple test rigs used are fundamentally either open channels, which give visualisation in two dimensions, or three-dimensional systems in which the flow is enclosed as in the system being investigated.

OPEN SYSTEMS

Open water channels are used to visualise the flow round or through two-dimensional models of a simple type.

The working section is a channel 2 ft wide by 5 ft long, with a glass floor sloping to compensate for boundary layer thickening. For quantitative work, an electric probe, used in conjunction with a clock micrometer, is mounted on traverse rails, and water depths can be measured to 0·002 in.

The flow streamlines are indicated by a tracer powder sprinkled on the surface of the water as it flows along the channel ahead of the model, or by ink streams injected below the surface.

In flow problems involving rapid changes of flow area or direction, losses are largely associated with flow breakaway, and this is readily studied in the open channel. In interpreting results, the effect of overall contraction or diffusion in the three-dimensional component must be considered, but obviously flow breakaway shown in the two-dimensional model will be intensified if a further overall adverse pressure gradient is imposed, and improvements in the two-dimensional shapes will be reflected as improvements in the complete duct performance.

Two-dimensional analysis may also be used for developing complex passages where three-dimensional flows are important; breakaway is still the major cause of loss, and detailed improvement in flow shapes can often be made by testing two-dimensional "slices" at suitable planes.

Work in the open water channel is regarded here as an essential preliminary to most flow passage development problems. Its outstanding advantage is its simplicity; by using aluminium sheet, plasticine and other easily manipulated materials, variations in passage shape and layout can rapidly be investigated, and after a few hours work a satisfactory standard can usually be evolved for a complete three-dimensional model of the component for final airflow testing. Used in this way, the water channel results in considerable savings in time and cost.

The open water channel may also be used to investigate radial flow in two dimensions. This type of flow problem occurs often at the inlet to and outlet from turbo-machinery, and in particular, the effect of swirl in a plane normal to the axis of the machine may be investigated. Again, in the interpretation of the observed flow patterns, the strictly two-dimensional nature of the flow must be remembered. The use of radial flow, with or without swirl, calls for rather more elaborate test models but the cost of a single test model can still be measured in tens of pounds rather than hundreds.

The same test facility may also be used to simulate the propagation of sound waves and the pattern of shock waves in a gas flow, by examining the propagation of surface waves. The pressure and density fields in the gas flow are analogous to the variations in depth of the water flow, and the presence of shock waves is shown by clearly defined "water jumps."

The analogy to shock waves has certain limitations which must be observed. The variation in depth of the water can only be related exactly to a special gas in which

$$\gamma = C_p/C_v = 2,$$

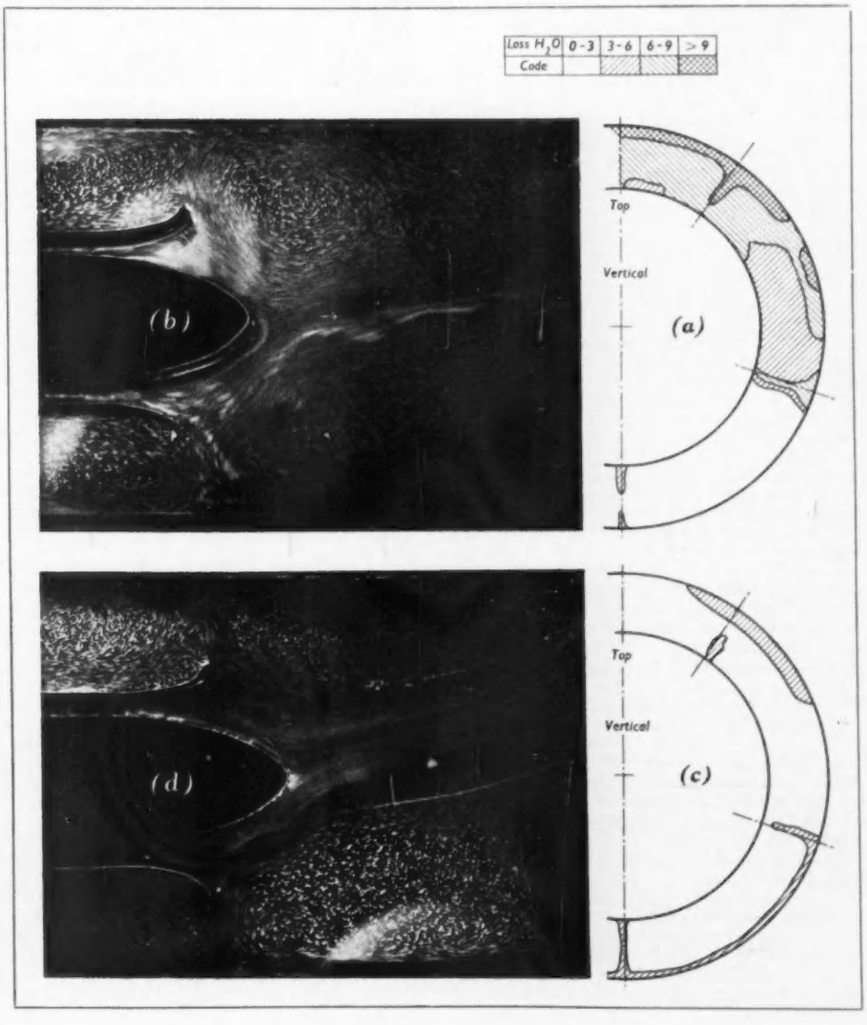
where

C_p = Specific heat at constant pressure

C_v = Specific heat at constant volume.

The value of γ for air, of course, is 1·4.

Fig. 1 Flow into compressor intake; (a) and (b), original design; (c) and (d), final design.



Shock wave patterns, however, do not vary much with γ at low supersonic Mach number, say up to 1·5, and even above this the qualitative picture is largely unchanged.

A second limitation is that the theory assumes that

$$C^2/gh = 1$$

where C = velocity of a surface wave,
h = depth of water,
g = gravitational constant.

In practice, the value of C^2/gh is dependent upon the magnitude of the surface tension and the ratio of the wavelength of the surface wave to the depth of the water, so that for normal-size models it is desirable to maintain a water depth between $\frac{1}{8}$ in and $\frac{1}{2}$ in to obtain experimental results which will approximate to the theory.

To assist flow visualisation of "shocks," it has been found convenient to use a striped black and white board under the glass floor, the distortion of these black and white lines forming a very convenient means of determining the location of these surface waves. In using this method considerable care is needed, as for each Mach number there is a maximum depth of water above which capillary waves may be obtained on the surface, and these can give very misleading results.

The application of the analogy to transonic flows calls for a high degree of judgment in interpreting the observations. In this region, shock-boundary layer interaction becomes prominent and correct similarity becomes essential. Nevertheless, this analogy shares with the other applications of the two-dimensional channel the outstanding advantages of speed and simplicity, and its use can result in considerable savings in time and cost.

Another application is the study of pulsing flow in ducting components, an important factor in the performance of turbo-blowers fitted to diesel engines; in this case pulses are superimposed on a steady flow by a paddle wheel.

ENCLOSED SYSTEMS

Unlike the open circuit, the closed three-dimensional water flow analogy is exclusively an incompressible flow relationship. The effect of density changes in a gas flow cannot be reproduced, and the application is limited to gas flows in which there are no significant compressibility effects. Also, the change of volume in a gas due to heat addition in the system, e.g., in a combustion chamber, is not represented, but this does not detract from the value of studying the cold-flow patterns on a comparative basis. In fact, such methods are the only practical way of examining the airflow patterns in combustion chambers. In particularly complex flows, conventional pressure readings alone often cannot be interpreted without the assistance of flow visualisation.

The test rig at the Napier Research Station employs a cylindrical steel tank of some 80 gallons capacity which acts as an upstream settling chamber. This tank is fed by a pump similar to that used for the open channel, and the working section is on top of the tank. A bellmouthed entry section leads the flow into the test model, and the water returns through an overhead pipe to the open storage tank. Vertical orientation of the working section was chosen to minimise the effect of any density variations between the main fluid flow and the tracer particles, and to facilitate observations across all cross sections of the models.

The working section is surrounded by a rectangular tank having transparent walls and filled with static water. This is necessary for models having curved exterior surfaces in order to reduce refraction and reflection of incident light by the curved surface. This static tank can be rotated round the axis of the working section to present a normal face to light incident along any section through the model.

Again, similarity of flow between the gas in the system being studied and the water in the analogue is achieved by operating at the same Reynolds number, and the increased density of water contributes largely to the achievement of high Reynolds numbers at moderate fluid velocities. However, limitations of plant capacity and in the mechanical strength of the transparent models required for this technique often force some relaxation of rigorous similarity requirements. This difficulty is found in all the available accounts of water channel testing, but the values of Reynolds number which can be achieved in the usual type of model manufactured from thin transparent sheet are so greatly in excess of the critical values that quite large variations have no significant effect on the flow pattern.

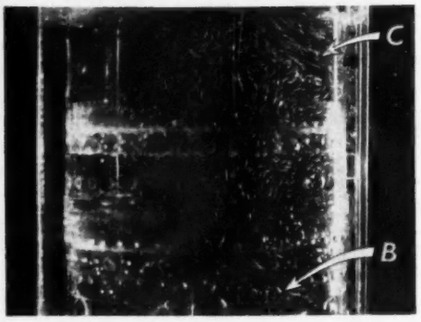
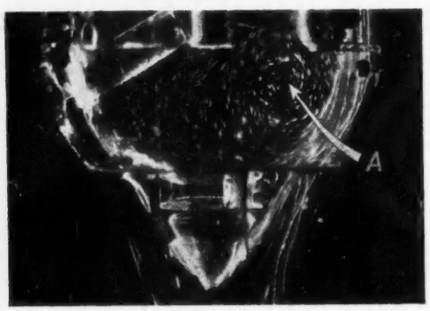


Fig. 2 Flow in a three-dimensional model of a gas-turbine flame tube; (A) stationary vortex pattern required to stabilise the flame in the combustion zone, (B) inflow from a ring of primary dilution holes, maintaining the combustion vortex, (C) larger inflow of dilution air reducing the temperature of the combustion products to an acceptable level.



Although the closed water flow channel is used primarily for flow visualisation, it is also possible to measure pressure drops through the test model, and these are found to agree fairly well with air test results. A model suitable for the water flow rig may also be suitable for air tests, and it has been found preferable to use the water channel as a visual aid, and to obtain quantitative results by instrument traverses on an airflow rig.

Finally, the application of a water flow visualisation rig need not be limited to stationary duct flow problems, but can be extended to rotating turbo-machinery. Some interesting results have been obtained at the Napier Research Station from a transparent model of a centrifugal compressor, including observations of the flow patterns in the rotating impeller. The application of water flow visualisation to reciprocating fluid machinery has not yet been attempted, but would be of particular value in examining the flow through valves, and in scavenging.

APPLICATIONS

Development of a Flow Passage

In the Eland engine, as used in the Fairey Rotodyne aircraft, an auxiliary compressor is driven from the back of a standard Eland engine, the air intake facing rearwards. The aircraft manufacturer's installation required a plenum chamber intake for the auxiliary compressor, with a duct from a specified air intake on the upper surface of the wing, leading to a fixed hole in a bulkhead appreciably off the centre line of the compressor.

The results of instrument traverses on the original intake under airflow test can be seen in Fig. 1(*a*) which shows bad distribution at the plane of the auxiliary compressor inlet guide vanes which would have resulted in severe loss of compressor performance. The water-channel photograph, Fig. 1(*b*), illustrates the flow in a two-dimensional model of this original arrangement, and the second photograph, Fig. 1(*d*), shows the water flow in a model of the final arrangement after water-channel development. The intervening work to determine the best shape for the duct showed that the length and position of the projecting snout was critical, and that supporting the end of the snout by a false bulkhead resulted in stronger vortices contracting the main flow out of the snout. The airflow model was modified on the basis of these tests, with the results shown in Fig. 1(*c*).

The example given offers no problems of interpretation. The inlet duct, though varying in shape to fit specified holes in the wing and bulkhead, is of constant area, and for many cases it is sufficient to remember that an overall acceleration will reduce the magnitude of breakaway, while an overall deceleration will increase the flow separation.

Care is needed with sharp bends on the secondary flows in the boundary layer on the tunnel floor can detach the flow from the inside of the bend and give a false picture. As a general rule, the detachment resulting from secondary flow is a severe limitation on the development of bends with much curvature.

For most of this work the low value of Reynolds number (1 ft per sec is equivalent to a Reynolds number approximately 92,000 per ft dimension) is not considered important.

Radial Flow in Two Dimensions

A number of experiments have been carried out on vaned diffusers for centrifugal compressors. In this case swirl is imparted to water flowing through a vertical duct by means of a small paddle wheel driven by an electric motor. This water flows upwards and discharges on to a horizontal table on which is located the diffuser. This produces a two-dimensional swirling flow about a vertical axis and simulates the impeller discharge conditions. The flow in the passages of various types of vaned diffuser has been investigated, together with the interaction between flow in the collecting duct and the diffuser. The location of the volute tongue with respect to the diffuser vanes has been found very critical especially at low flow rates, there being a pronounced backward flow in the gap between the volute tongue and diffuser blade trailing edges.

Development of Cascade Blades

Some useful work has also been carried out on cascades of blades, but in this case great care is required in interpreting results, because of the low Reynolds number, it being impractical to exceed $R_e = 0{\cdot}5 \times 10^5$.

Some experiments with cascades of compressor blades showed that both the operating range and critical Mach number could be determined with a fair degree of accuracy by this method. It was noted that shock boundary layer interaction phenomena, very similar to those seen in Schlieren photographs, were observed. This is of particular interest since in the waterflow rig these effects result from the combination of two different analogies.

A series of tests has also been carried out to determine the optimum relationship of two successive compressor cascades used for high deflection. The optimum arrangement, which also should have the highest critical Mach number, is with an equal number of blades in each row, the leading edge of the second row of blades being slightly off-set towards the under surface of the first row, giving an arrangement similar to a slotted wing.

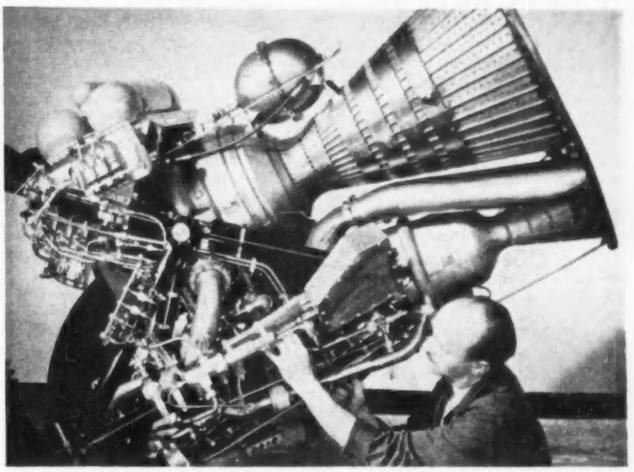
In an early investigation connected with

Stentor Rocket Engine Developed for Blue Steel

First details of a new rocket engine, the Stentor ASSt1-1, have been announced by Bristol Siddeley Engines Limited. The new engine, which is now in quantity production, is for the Blue Steel missile. Like the Siddeley Gamma engine, which is used for Black Knight, the Stentor burns kerosine with hydrogen peroxide in high pressure combustion chambers.

The Stentor has two chambers, one about four times as large as the other. To start the engine, hydrogen peroxide is expelled from a starting tank by pressurised nitrogen and decomposed in a catalytic steam generator which supplies steam to the turbopumps. When the turbine reaches an appropriately high speed this supply of hydrogen peroxide is provided by the pumps, which feed the combustion chamber.

Each combustion chamber contains a catalyst pack. Hydrogen peroxide passing through this into the combustion zone is decomposed into a mixture of oxygen and superheated steam. Fuel injected into this mixture ignites spontaneously and the products of combustion are accelerated during their passage through the expansion nozzle.



The Stentor rocket engine, used for the Blue Steel missile, has two high-pressure combustion chambers, burning kerosine with hydrogen peroxide. Each combustion chamber contains a catalyst pack which assists in decomposing the hydrogen peroxide into a mixture of oxygen and superheated steam.

On its way to the combustion zone, the hydrogen peroxide passes down to the end of the expansion nozzle, and back to the top of the chamber through passages in the chamber wall, so acting also as a coolant during firing. Nitrogen is used to purge the fuel injectors before and after each run, to ensure predictable behaviour.

In order to keep the engine in good condition throughout long periods of storage, means are provided to dry out the hydrogen peroxide system with hot air after test firings; a technique proved on the Gamma engine.

Two Hundred Parameters in Process Control

The immediate aim of instrumenting a process or a machine tool is to check by various measurements how well it is operating. But although the immediate aim may be simply to detect variations, the longer-term purpose is to operate the plant automatically. Thus any unwanted variation in measurement should produce a signal which will actuate a controller so as to correct the variation. The subject, therefore, can be reviewed under three headings—detecting elements, indicators and recorders, and controllers—all three of which are used, ideally, to control a production line or process. Dr. J. Thompson, director of the British Scientific Research Association, makes these observations in "Instrumentation and Automatic Control in Industry," an article published in *Research for Industry 1959*, issued by the Department of Scientific and Industrial Research (HMSO, 8*s* 6*d*).

The first essential is a comprehensive set of "detecting elements"—devices which can detect changes in the conditions measured—for example, temperature, pressure, acidity (or alkalinity) of a component, mass flow, density and viscosity, and indicate these changes on a meter. The BSIRA estimates that there are about 200 kinds of measurement which are industrially important and that detecting elements can be made for all of them, even though in many cases they cannot be entirely satisfactory at present.

One factor which limits the speed of progress at present is a lack of knowledge about the dynamics of a plant or a production line. For example, if a large chemical plant is to be controlled automatically, it is necessary to understand completely first the mode in which the process varies with a change in the measured condition; and second, the time lag between the correction applied and the detection of a system response. The mathematical techniques which have been evolved for "plant analysis" of this kind, though elegant and most interesting, are usually not comprehensive enough, and even when comprehensive are often very complex and unwieldy. For that reason it is necessary to simulate the action of the plant on an analogue computer, or to carry out direct experiments on the plant using special instruments. Both methods are being employed at the moment by several large chemical firms.

Concluding **Water Flow Analogues**

rationalising turbine blade design, several experiments were made with turbine cascades to investigate such points as the effect of nose shape on operating range, shock patterns on straight and curved blade upper surfaces after the throat, detection of early shocks formed in blade passages, and investigation of supersonic impulse blading, etc.

Complex Three-Dimensional Flow Problem

Figure 2 shows an example of the type of complex flow pattern existing in a gas turbine engine combustion chamber, using air bubble tracers. Development work on this type of flow can only be carried out by flow visualisation techniques, and development work is always necessary as no analytical approach could account for the large number of variables affecting the flow. Particular features of the flow pattern illustrated by Figure 2 are, at A, a stationary vortex pattern required to stabilise the flame in the combustion zone; at B, the inflow from a ring of primary dilution holes serving to maintain the combustion vortex and to supply air for combustion; and at C, a larger inflow of dilution air in order to reduce the temperature of the combustion products to an acceptable level.

The photograph gives only an inadequate picture of the appearance of the visualisation rig, as it is difficult to obtain perfect photographs using models having curved surfaces. In addition, since the flow is highly turbulent, the instantaneous velocity at a particular point in the pattern may undergo variations in magnitude and direction about the characteristic mean, so that a single instantaneous photograph can never fully be representative. With models of this type, it is more satisfactory to study the flow visually for some time and take records in the form of sketches.

The three-dimensional water-flow visualisation rig has its greatest value in the study of regions where the derivation of a flow pattern from pressure plotting would be difficult and tedious. Models of this type of system are more expensive than those required for two-dimensional analysis, but in many cases this is the only way in which a clear picture of the various flows may be gained. Recently, this technique has been extended to observation of the flow in the impeller and diffuser passages of a centrifugal compressor. To relate the observations to compressor operating conditions, the flow rate and pressure rise were measured for each observation and expressed as pressure coefficient and flow coefficient. The observations of impeller passage flow were obtained using a camera rotating with the impeller.

One of the interesting results was the presence of high velocities along the leading faces of the vanes, which is in contradiction to the conventional theory of impeller flow, but in agreement with some other experimental observations.

Experience over a considerable period has shown that the two dimensional water channel is a piece of apparatus which is of great value in preliminary flow-passage development, and also, with due precautions, for cascade development. Its great advantage is its simplicity and flexibility, modifications to the shapes under test being very easily made with simple materials.

Three-dimensional water flow visualisation tests, while requiring rather more elaborate models, have considerable application in the development of complex passage shapes, and in studying flow stability in ducts. While considerable progress has been made by conventional airflow tests on models of such passages, flow visualisation tests are usually essential for a complete understanding of the flow.

Acknowledgement

The work described in this article was carried out at the Napier Research Station, Liverpool, and the authors' thanks are due to D. Napier and Son Limited for permission to publish this article. Opinions expressed are the authors' own.

Hi-Fi: Tapes and Speakers

By G. V. Buckley, A.M.I.E.E.

AT THE present time, pre-recorded magnetic tapes, known as tape records, for monophonic and stereophonic reproduction, use a tape speed of 7½ in per sec, are recorded half track on ¼ in width tape and are generally loaded on 7 in diameter spools. This gives a playing time per track of about 30 minutes when using standard thickness tape (about 2 mils) and about 45 minutes with long play tape (about 1·5 mil thickness). The cost of these tape records varies with the length and type of programme, but a full spool of good programme costs about £4. There are also some monophonic half track tape records using a tape speed of 3¾ in per sec available at reduced price and quality.

By halving the tape speed of a given equipment and using the same tape, there is, in general, a deterioration of the high frequency response and of the signal to noise ratio due to the increased wavelength losses caused by the replay head and the increased high frequency loss in the recording process. Re-equalisation in the amplifiers can sometimes restore the frequency response but at the cost of signal-to-noise ratio. However, it is now possible, due to videotape recording accomplishments, to design very much more efficient heads and tape which can recapture this lost signal-to-noise performance. The cost of a high grade stereophonic tape recorder/reproducer having tape speeds of 7½ and 3¾ in per sec is about £250, but by accepting limitations in performance and facilities this price can be reduced to about £70.

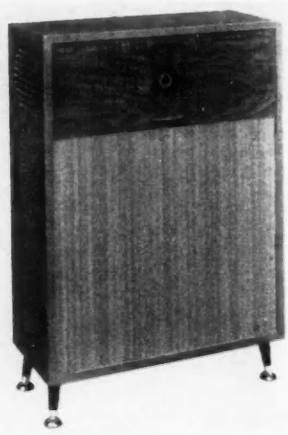
The trend in tape reproduction is towards lower tape speeds, more tracks on the tape and simpler tape decks incorporating cassette loading of tape. In this country four track machines with tape speeds as low as 1⅞ in per sec are starting to appear, with hints of corresponding tape records. Reports from America claim costs of tape equivalent to that of disc, using a tape speed of 1⅞ in per sec with cassette loading of specially developed tape giving a continuous playing time of 64 minutes for three track stereophony. It is further claimed that five cassette cartridges can be played in auto-change fashion with a performance equivalent to that of present day 7½ in per sec recordings.

These claims result from specially designed heads having a much higher efficiency than that of normal heads; they have effective gaps of 1·6 microns as compared to the normal 6·35 micron gap. The special tape is claimed to have a greater output of about 3 dB (for the same value of distortion), with an improved signal-to-noise ratio of 5 dB as compared with the oriented acicular particle tape used for video recording, which itself is said to have a 7 dB higher output and a 5 dB better signal-to-noise ratio than normal high grade audio tape.

Since about 1945 the standard of amplifier performance has been so high that more attention is now paid to its mechanics than to its electronics. The average amplifier used in high fidelity systems for living room volumes of 1,800 to 3,000 cu. ft has an output of about 10 watts, with a total r.m.s. distortion figure of less than 0·4 per cent, a virtually flat frequency response over the range 20 c/s to 20 kc/s and a noise level at least 60 dB below the full output. Associated with this power amplifier, generally as a separate unit, is the control amplifier which provides facilities for a selection of inputs such as radio, microphone, pick-up (crystal and magnetic) or tape, with controls for volume and correction of frequency response. These frequency response controls allow for the independent adjustment of the low and high frequency regions, with additional controls for adjusting the slope and cut-off frequency of a low pass filter. Their use is essential for optimum reproduction from the various types of programme source, and they can compensate for deficiencies of the loudspeaker system or room acoustics.

There is no doubt that the design of present day loudspeakers results more from scientific facts and measurements than from the idiosyncrasies of the designer. This is borne out by batch consistency performance which makes possible the theoretical requisite of stereophonic reproduction, namely, two identical loudspeakers. The great advance in measuring techniques and material research has resulted in enclosures, cones and magnets from which loudspeakers of moderate size and high class performance have been produced. Some of these loudspeakers have a frequency response extending from about 40 c/s to 16 kc/s. To attain such a low frequency response, a good 12 to 15 in diameter moving coil unit requires an enclosure volume too large for the average living room, but good approximations are achieved by much smaller systems using damped resonant enclosures.

The desired high frequency performance is obtained by using one or more smaller units mounted either co-axially with the low frequency unit or as separate units. Horn loading is employed with specially shaped horns or reflection techniques to achieve adequate diffusion of these high frequencies. These separate units are generally fed from the power amplifier via the cross-over networks which control the level and range of frequencies fed to them, and some loudspeakers are fitted with volume



The Slender Periphonic (by GEC) is an example of a loudskeaker designed for high performance in a compact cabinet.

controls on the networks feeding the high frequency bands so that the user can adjust the levels to the various units to suit listening conditions. The enclosures housing these units take many forms and must be positioned correctly according to their design; some enclosures incorporate the walls and/or the corners of the living room into their design. Some thought should therefore be given to available living room space before deciding on a particular type of enclosure, remembering also that the acoustics of the room may demand unorthodox positioning.

In general the design of the loudspeaker enclosure takes into account some of the acoustic problems of an average living room, such as adequate diffusion of the high frequencies at a height to avoid absorption by the soft furnishings. However, other room acoustic problems such as standing waves, vibrating windows or panels, and shadow effects must be solved by actual experiment. The price range of loudspeakers is considerable and is made complicated by the independent sale of enclosures and loudspeaker driving units, but between the limits of £30 and £60 are many first class models.

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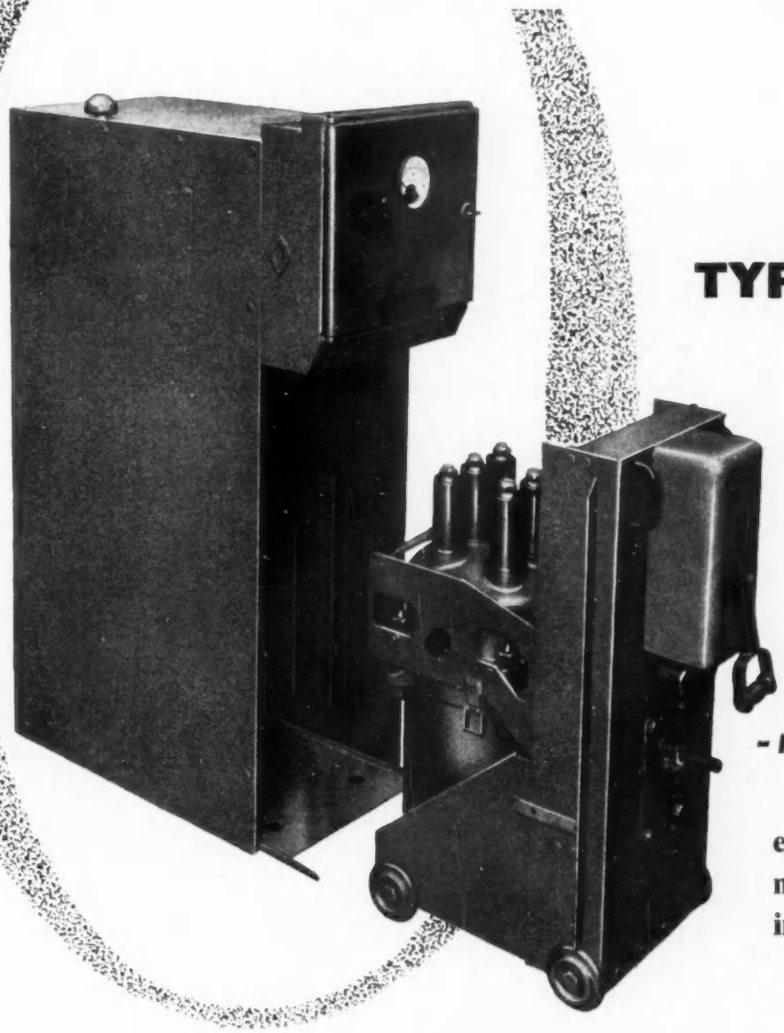

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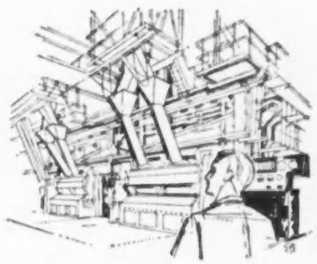

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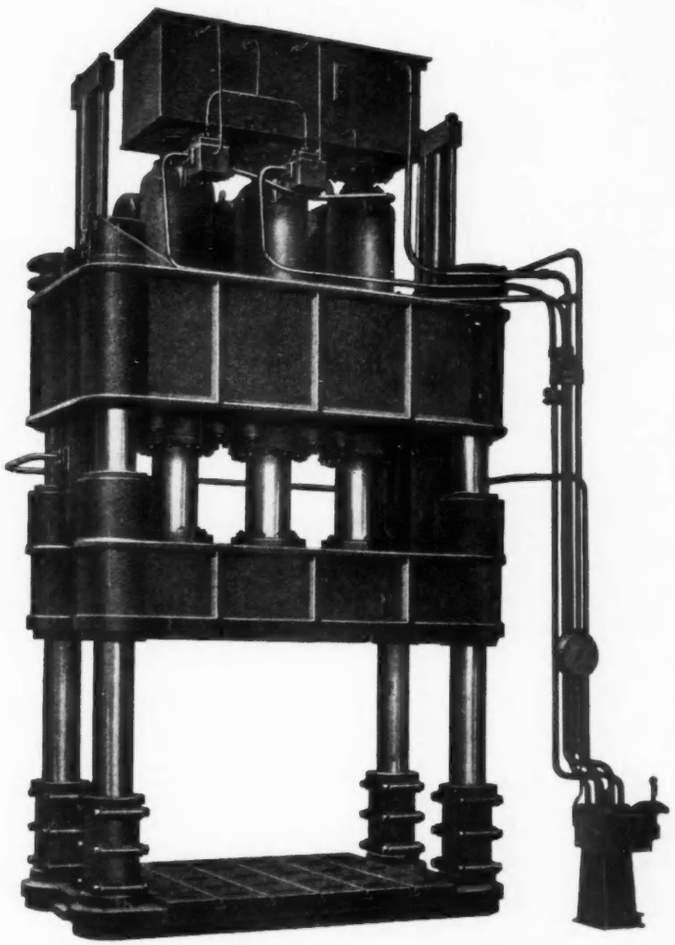

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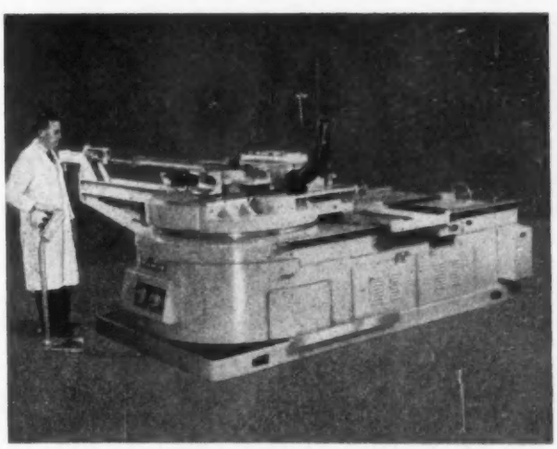

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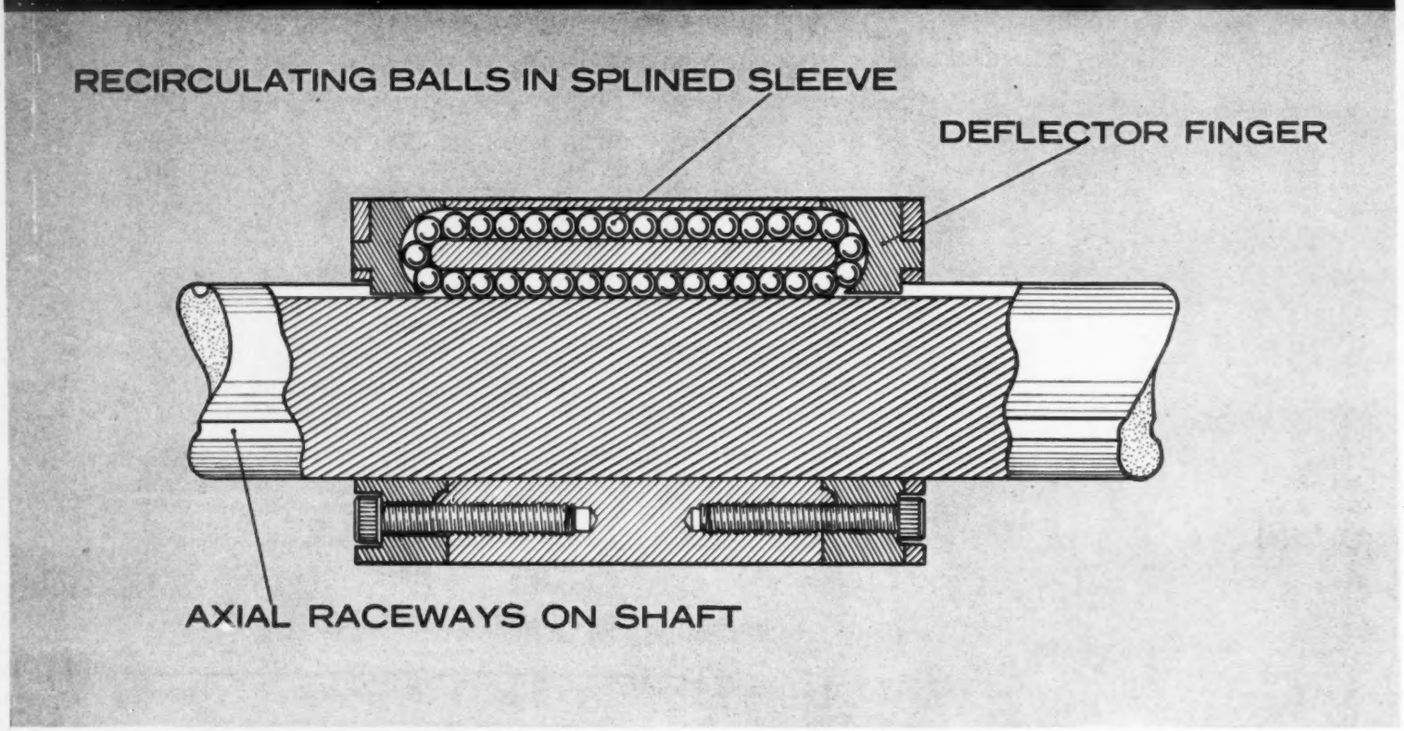

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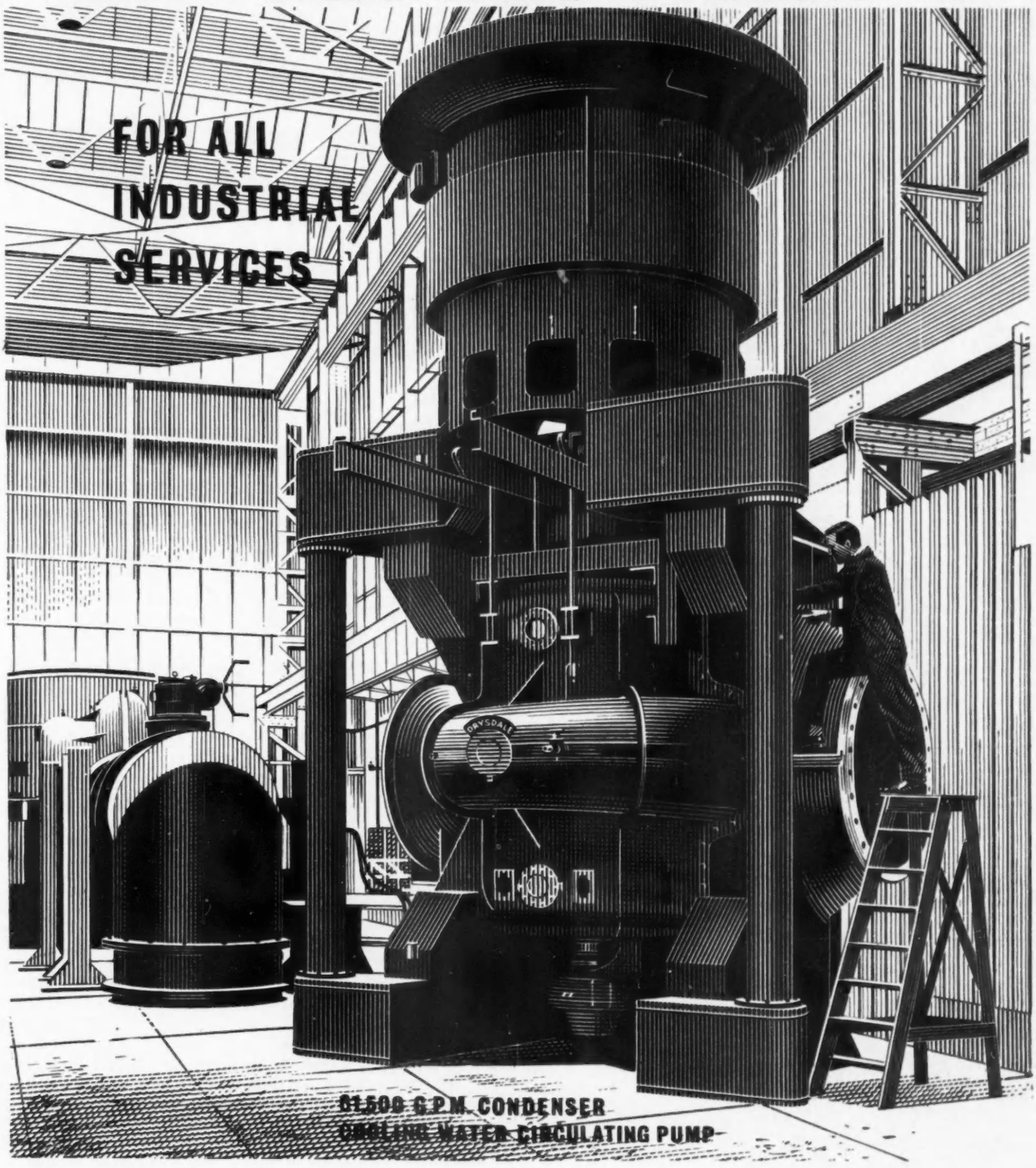

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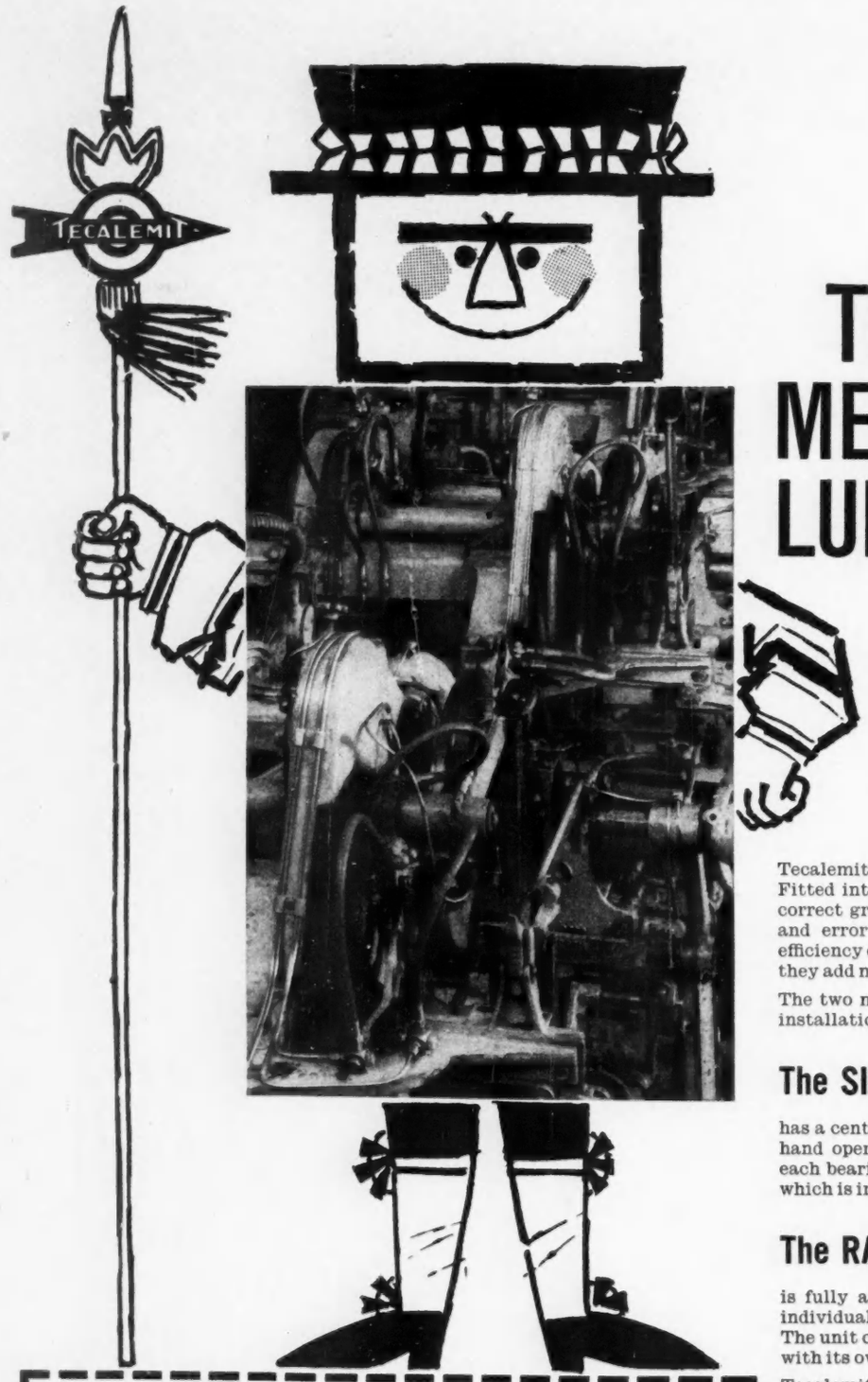

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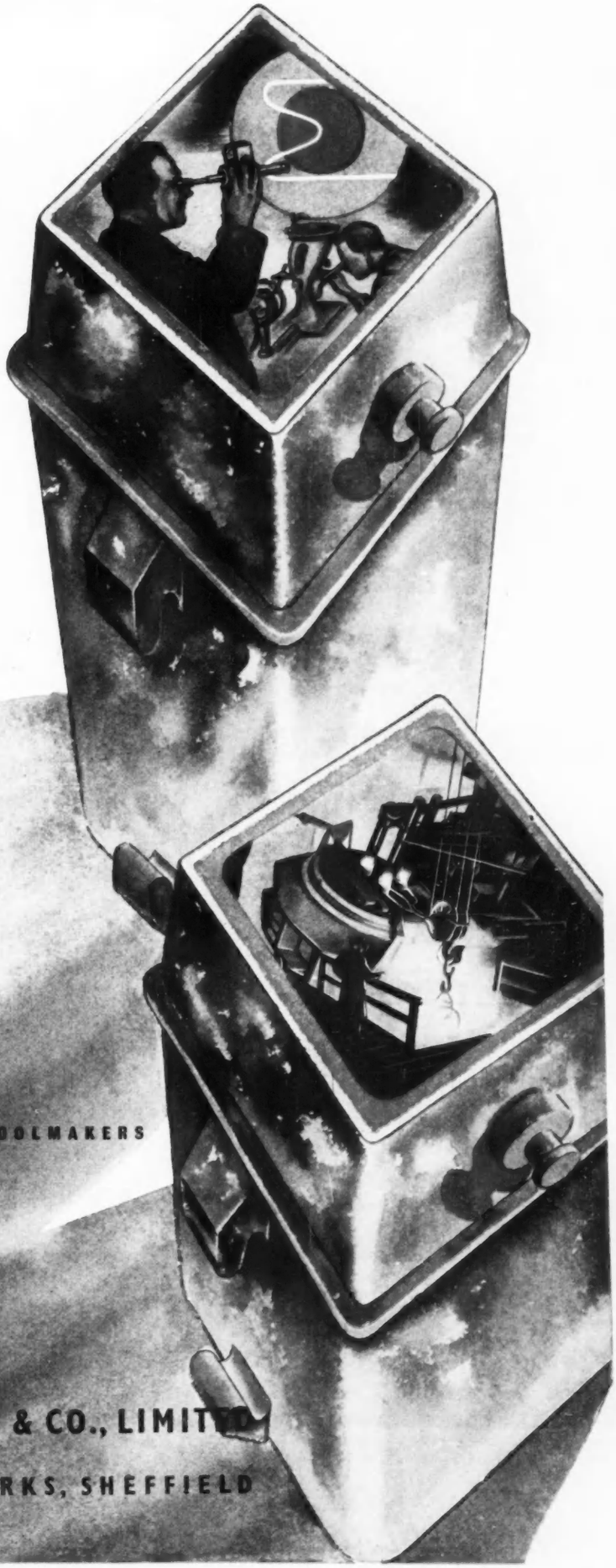

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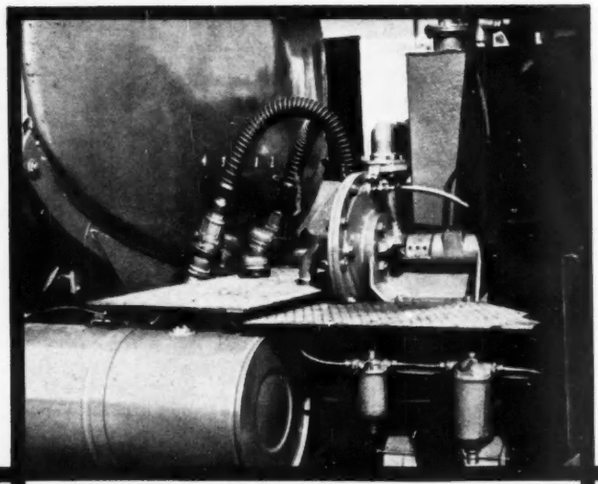
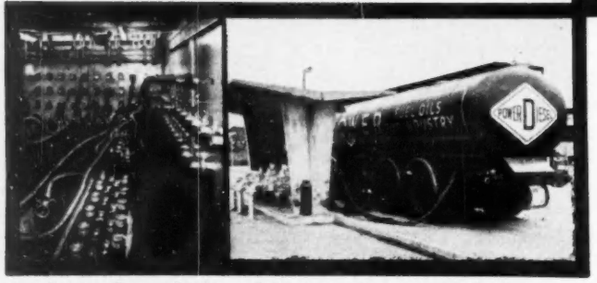


1¼" Self-Sealing Couplings in use on Vacuum Oil Company Tanks. (South Africa)



Hose Exchange Room at Stanlow. (Shell Refining Co. Ltd.)

Bottom loading-truck, using 2½" Self-Sealing Couplings. (Power Petroleum Co. Ltd.)

Avery Hardoll industrial couplings eliminate wasteful, dangerous spillage. Self-sealing valves prevent flow from starting until the Hose and Tank Units are fully coupled. On disengagement, the valves return to the self-sealing position before the Units are uncoupled. Avery Hardoll industrial couplings are widely used for rapid, safe bulk-handling in breweries, aviation, and for food processing industries.

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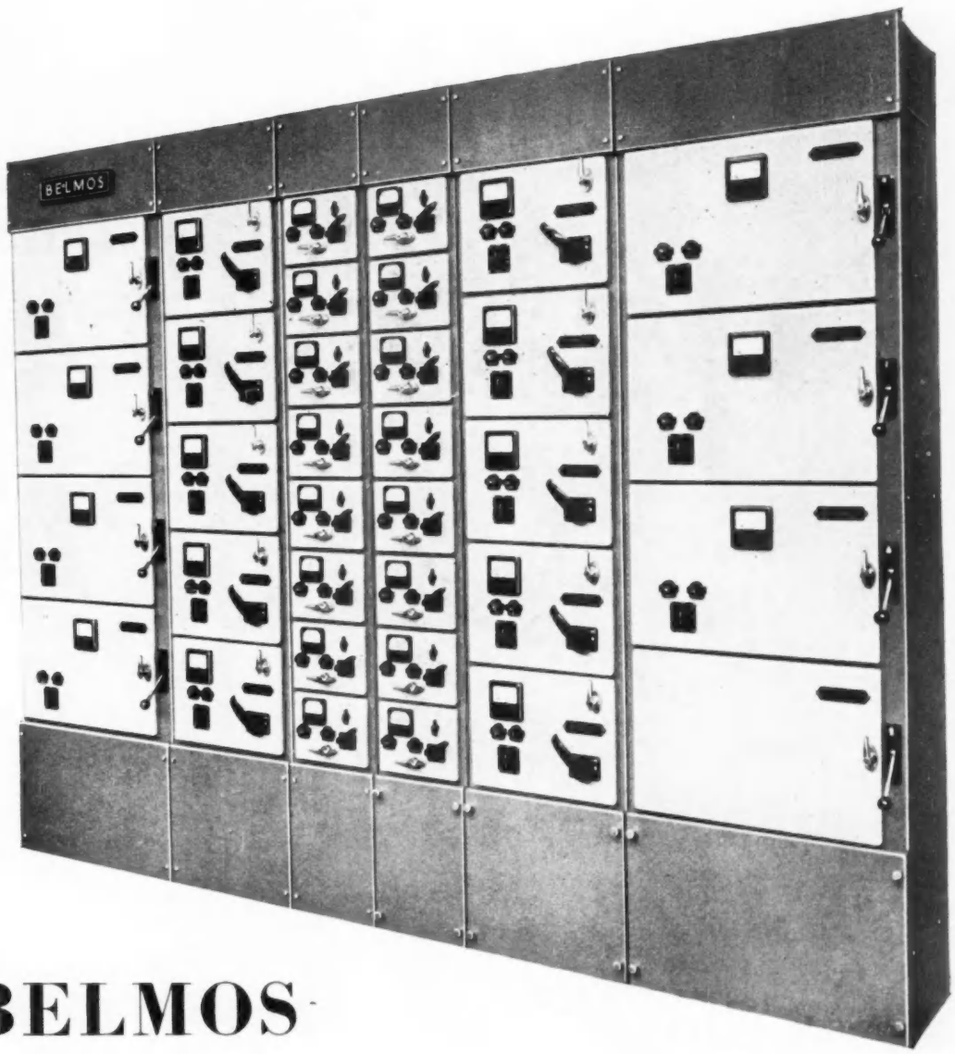

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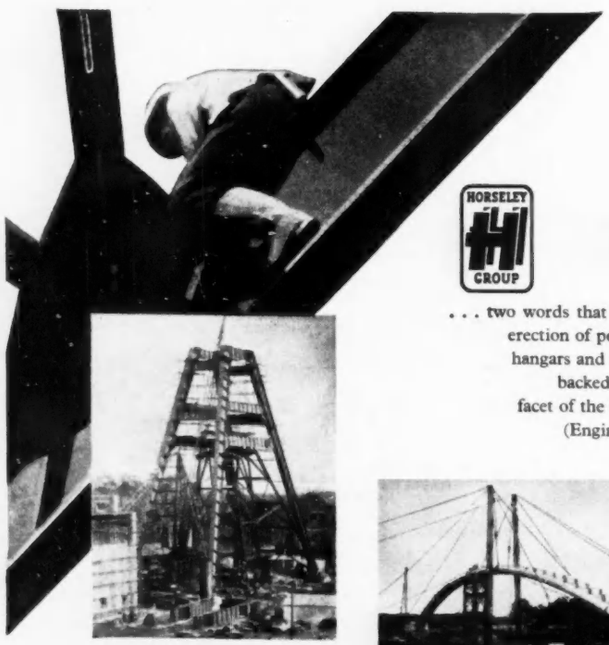

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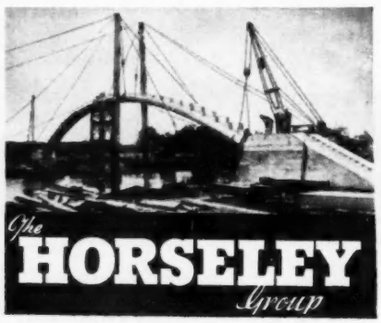

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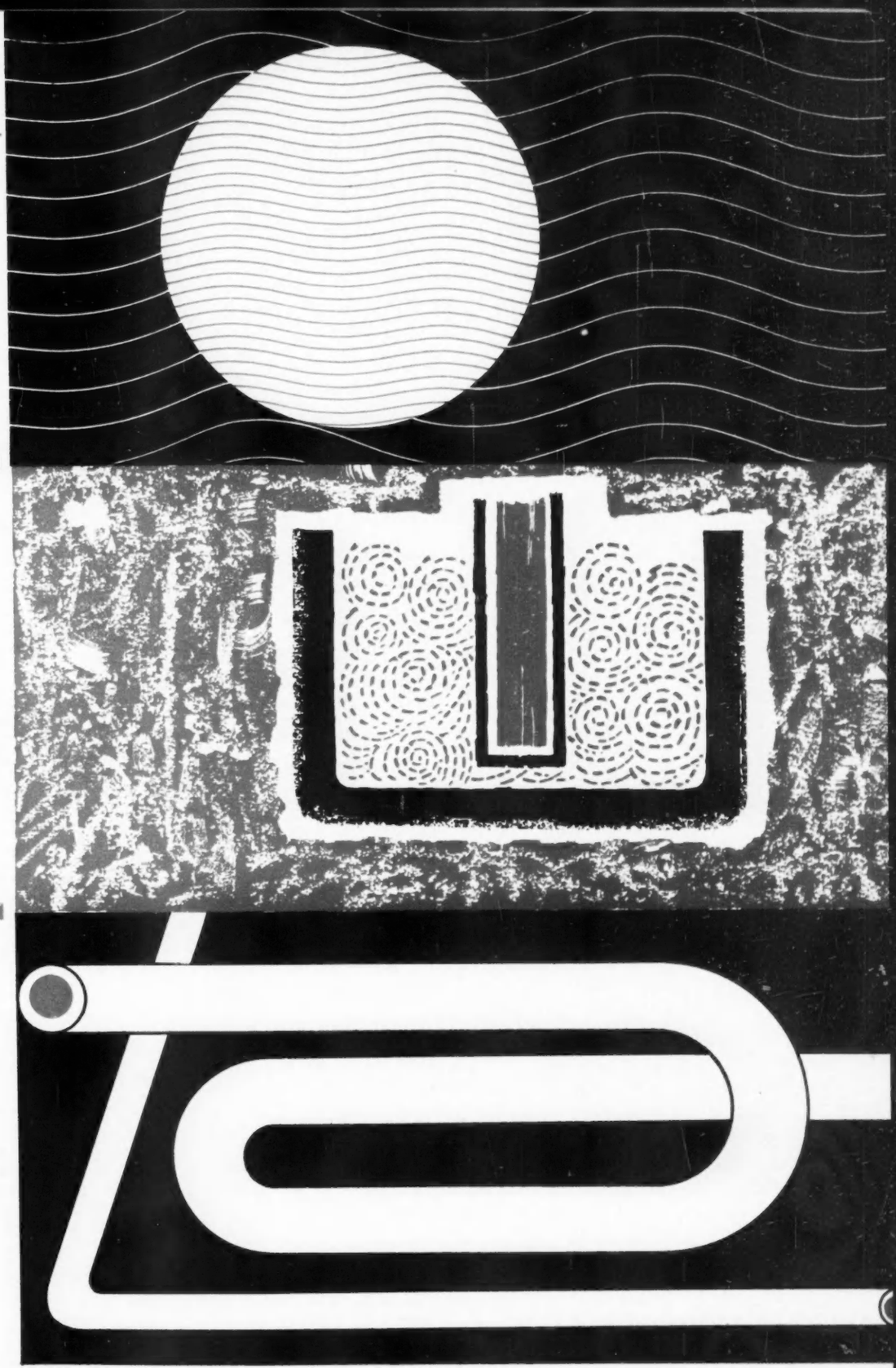

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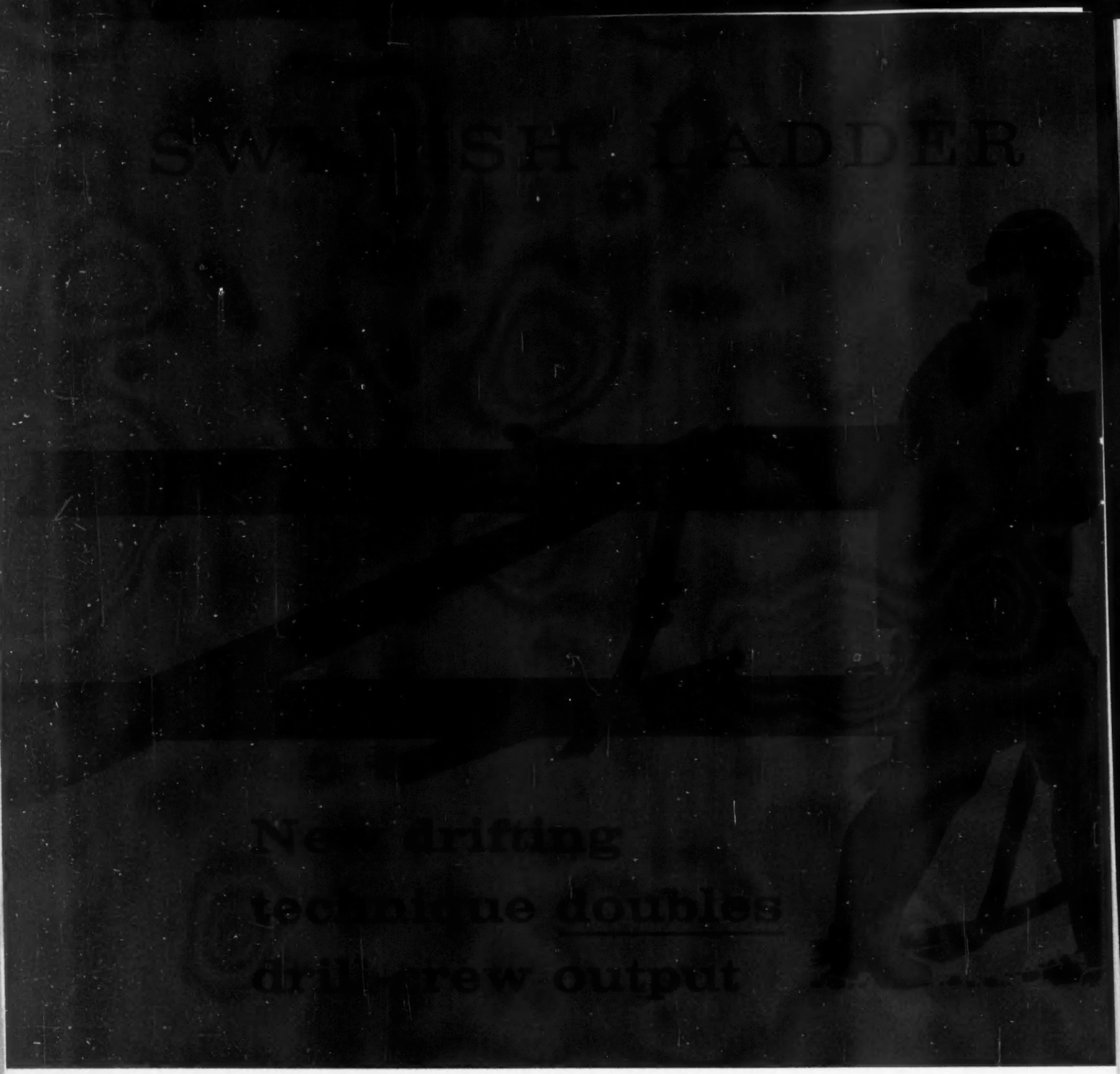

Controlled feed · guided collaring · mechanical retraction— so one man can operate two rigs

NORTHERN SWEDEN has been the proving ground of a revolutionary rock drilling method which has opened the way to a completely new conception of drill-crew output. Known as the Swedish Ladder Drilling Method, this new technique has been employed on hydro-electric projects at Korsselbränna and Stalon where drilling platforms with 16 rock drills operated by 8-man drill crews have been used.

Atlas Copco drills mounted on retractable pusher legs* are rested in cradles running horizontally in "ladders". Contractors and drill crews have found that these rigs, cheaply and simply constructed, offer the following advantages:

INCREASED PENETRATION—full feed power is ensured by the ideal horizontal feeding position of the pusher leg.

HIGHER OUTPUT PER MAN/HOUR—due to greater penetration and the fact that *one man handles two drills.*

REDUCED CREW FATIGUE—collaring is made simple as operators need not hold the drills. Drill steels are mechanically withdrawn from holes using the retractable pusher leg.

FEWER DRILL STEEL CHANGES—long steels can be used from the start. For greater durability 1" Sandvik Coromant integral steels are used.

GREATER DRILLING ACCURACY—thanks to the fixed ladder base and pre-positioning of drills for pattern drilling.

DRILLING METHOD

DRAMATIC RESULTS OF LADDER DRILL TESTS

The figures show the dramatic increase in drilling achieved by ladder rigs in a 60 sq.m. tunnel at Stalon driven in hard-drilled quartzite. Gross effect refers to the mean value for the whole drilling period, including collaring, changing steels and the usual routine delays. *Note that the gross effect is exactly doubled.*

GROSS EFFECTS

[redacted]

19.5 metres/man-hour Conventional drilling with one rock drill.

[redacted]

39.0 metres/man-hour Ladder drilling with two drills.

Available from Atlas Copco. The Swedish Ladder Drilling Method was originally introduced by Widmark and Platzer, one of Sweden's leading contracting companies, and has been further developed by them and by the Swedish State Power Board. Specially evolved with Atlas Copco trigger-operated retractable pusher legs*, this method and equipment has been exhaustively tested and proved under tough Swedish drilling conditions. There are Atlas Copco companies or agents in ninety countries and details of the new equipment are readily available from them or from the address below. Wherever you are, the international Atlas Copco group offers expert advice on the selection of equipment and a complete after-sales service.

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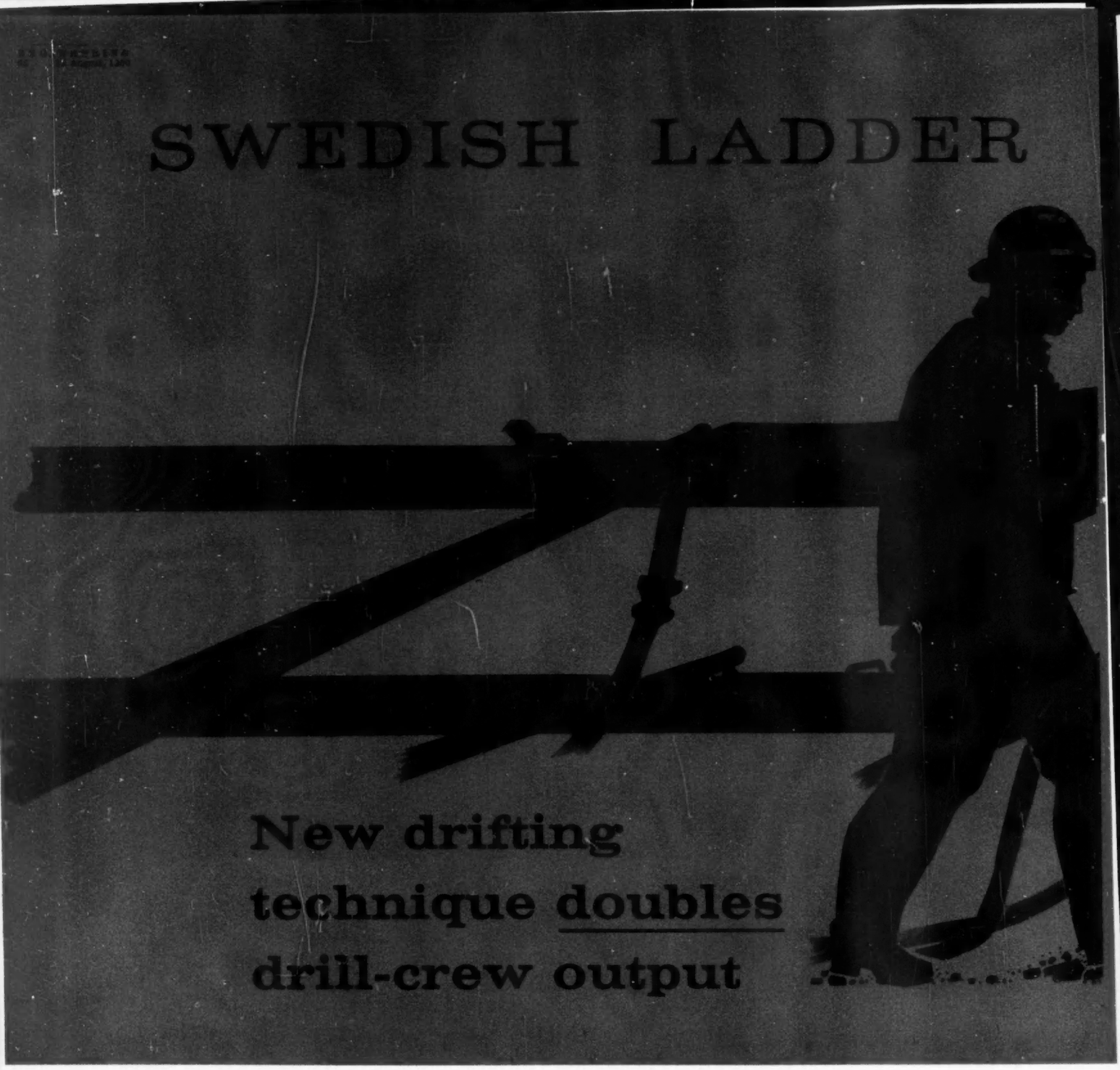
SWEDISH LADDER



New drifting technique doubles drill-crew output

Controlled feed · guided collaring · mechanical retraction— so one man can operate two rigs

NORTHERN SWEDEN has been the proving ground of a revolutionary rock drilling method which has opened the way to a completely new conception of drill-crew output. Known as the Swedish Ladder Drilling Method, this new technique has been employed on hydro-electric projects at Korsselbränna and Stalon where drilling platforms with 16 rock drills operated by 8-man drill crews have been used.

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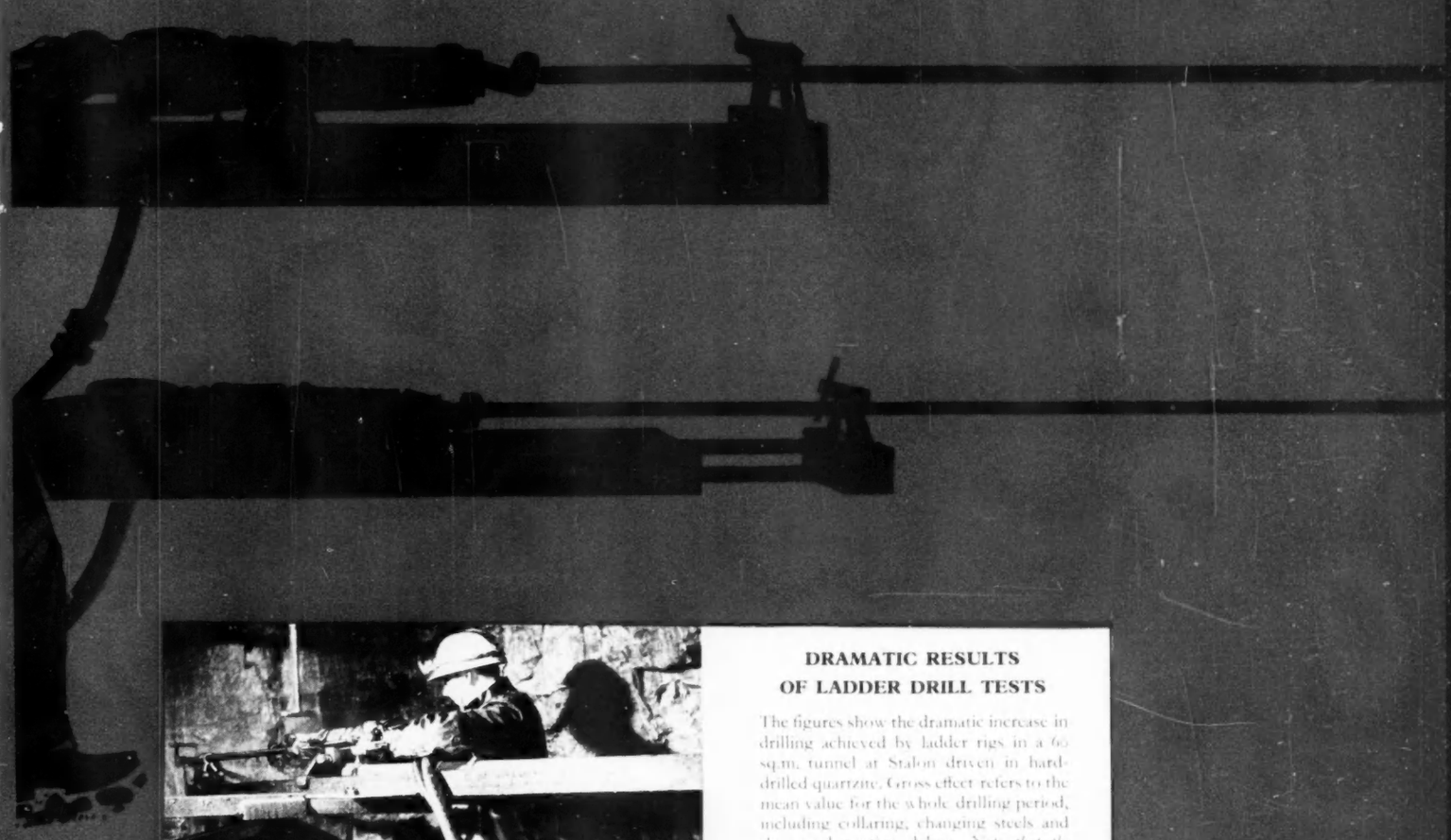
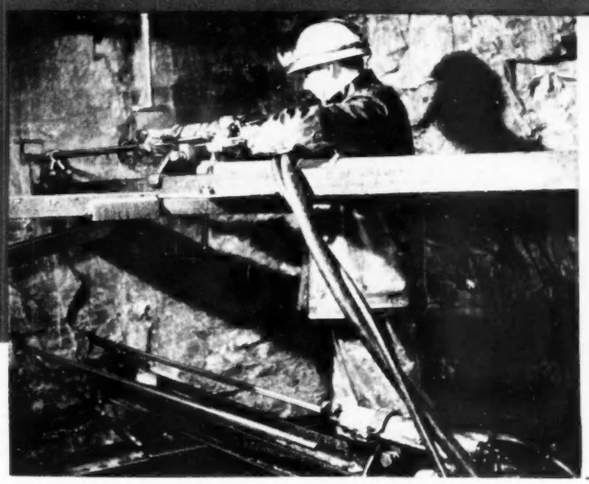
GREATER DRILLING ACCURACY—thanks to the fixed ladder base and pre-positioning of drills for pattern drilling.

DRILLING METHOD





DRAMATIC RESULTS OF LADDER DRILL TESTS

The figures show the dramatic increase in drilling achieved by ladder rigs in a 66 sq.m. tunnel at Stalon driven in hard-drilled quartzite. Gross effect refers to the mean value for the whole drilling period, including collaring, changing steels and the usual routine delays. *Note that the gross effect is exactly doubled.*

GROSS EFFECTS

1.9.5 metres man-hour Conventional drilling with one rock drill.

3.9.0 metres man-hour Ladder drilling with two drills.

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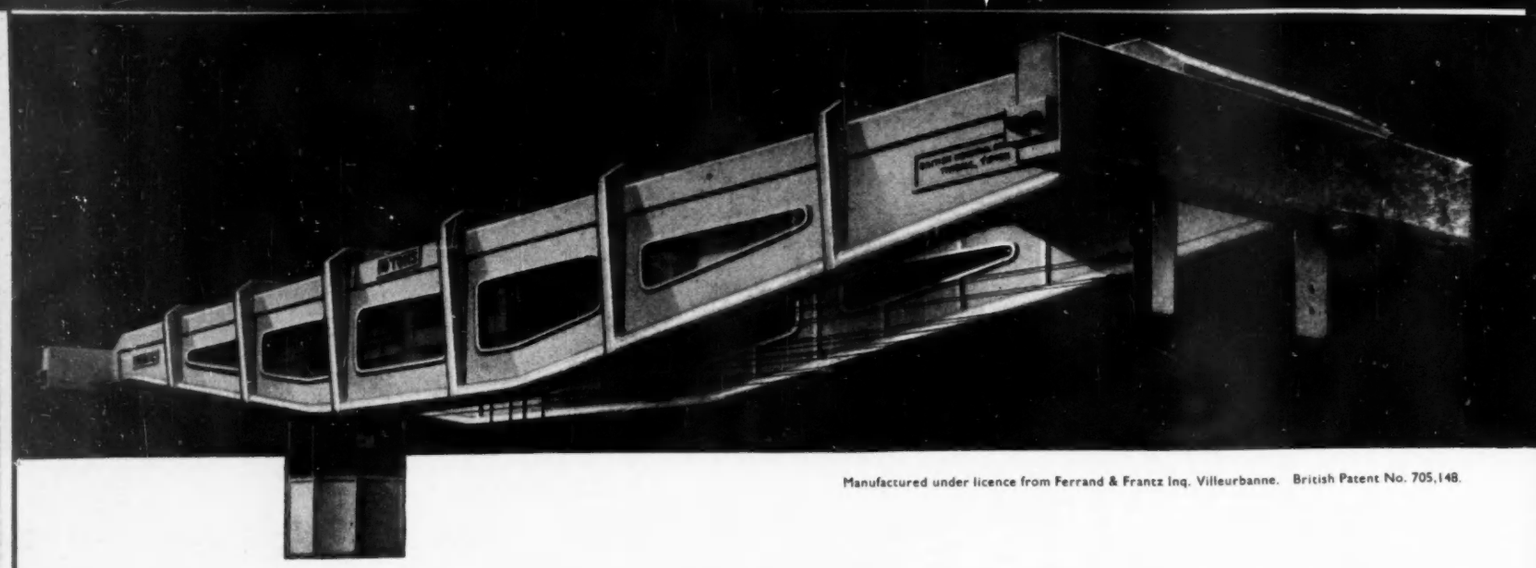

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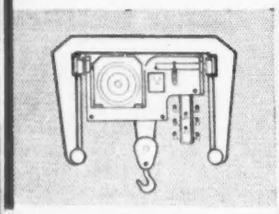

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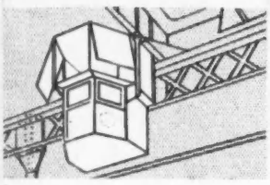

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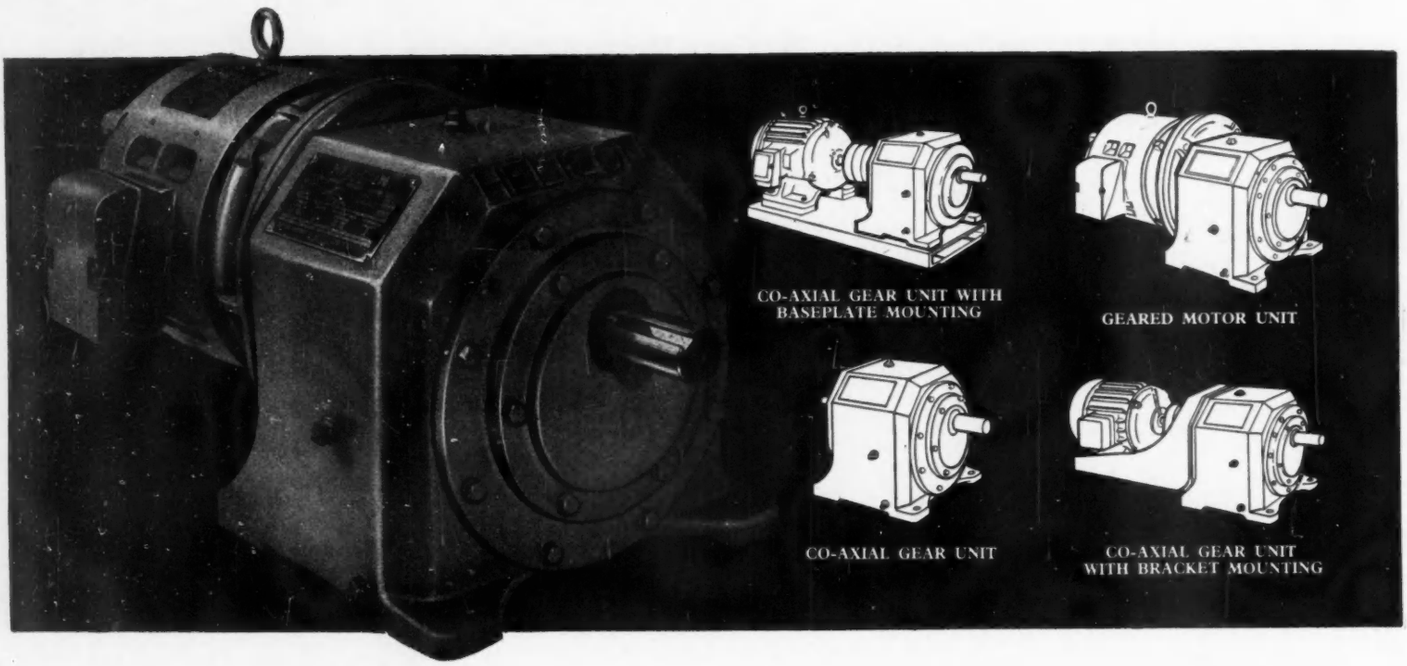
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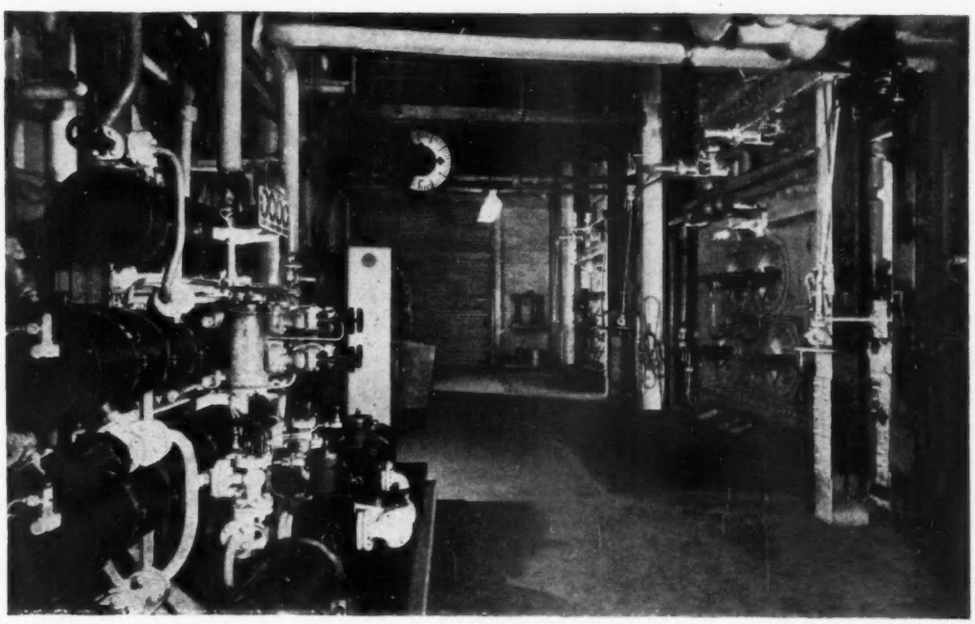

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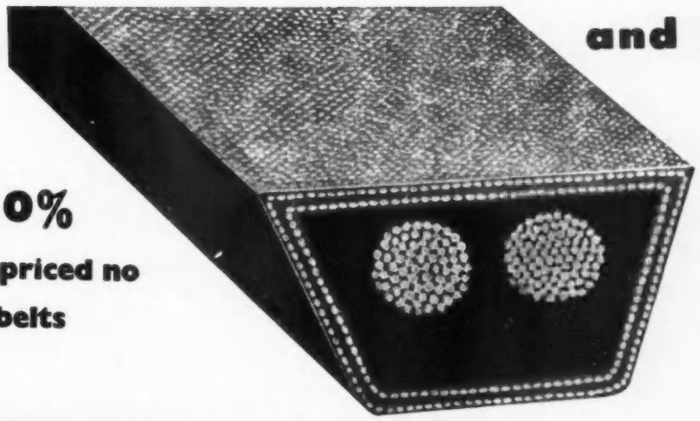

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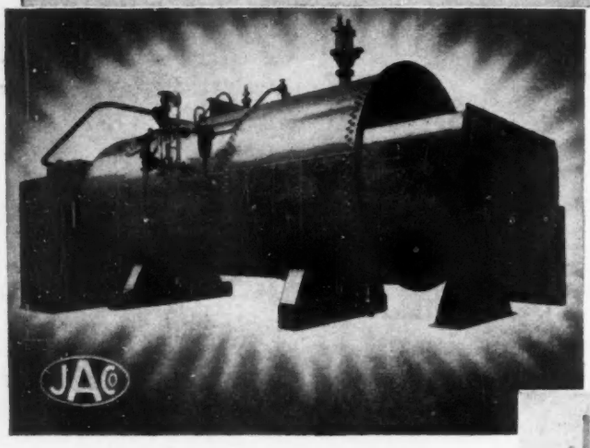

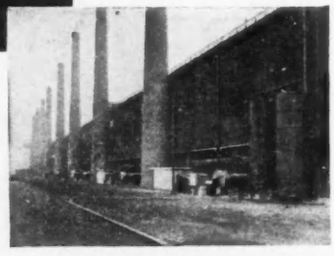

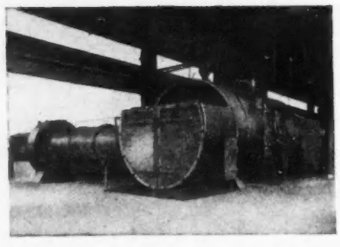

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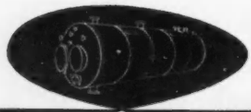

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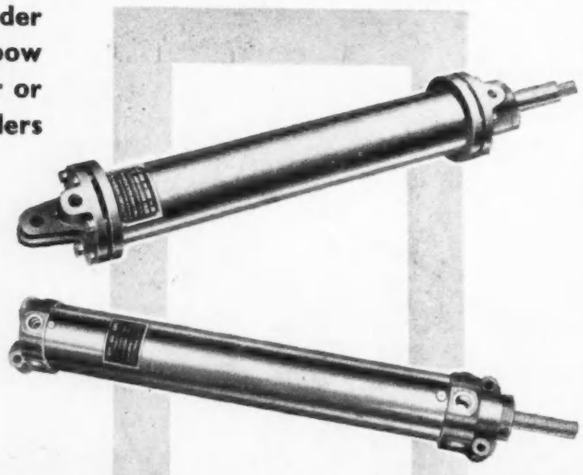

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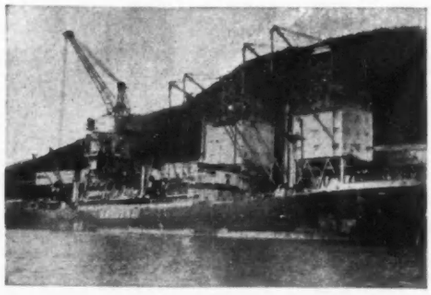

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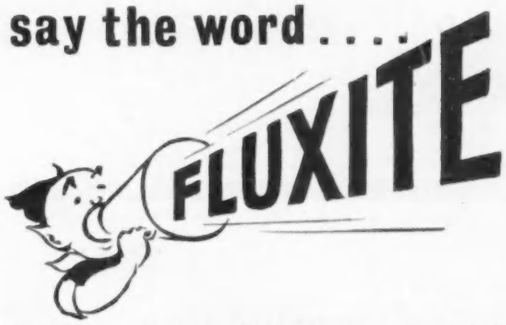

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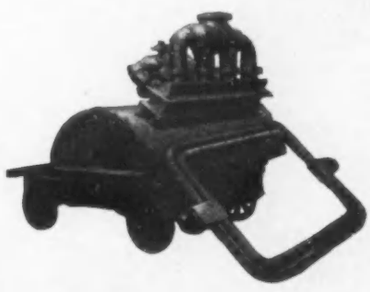

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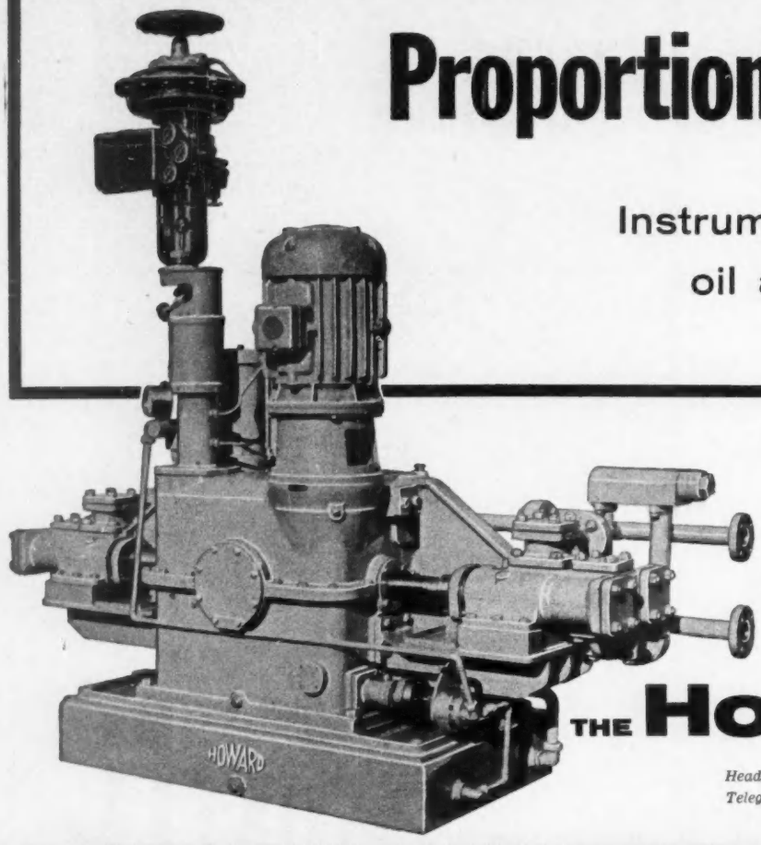
Instrument controlled for the oil and chemical industry



This illustration shows a 3 HL size double-ended pump, designed for a well-known oil refinery to pump hydrocarbons. It is fitted with instrument and ratio control for operating the output adjusting mechanism.

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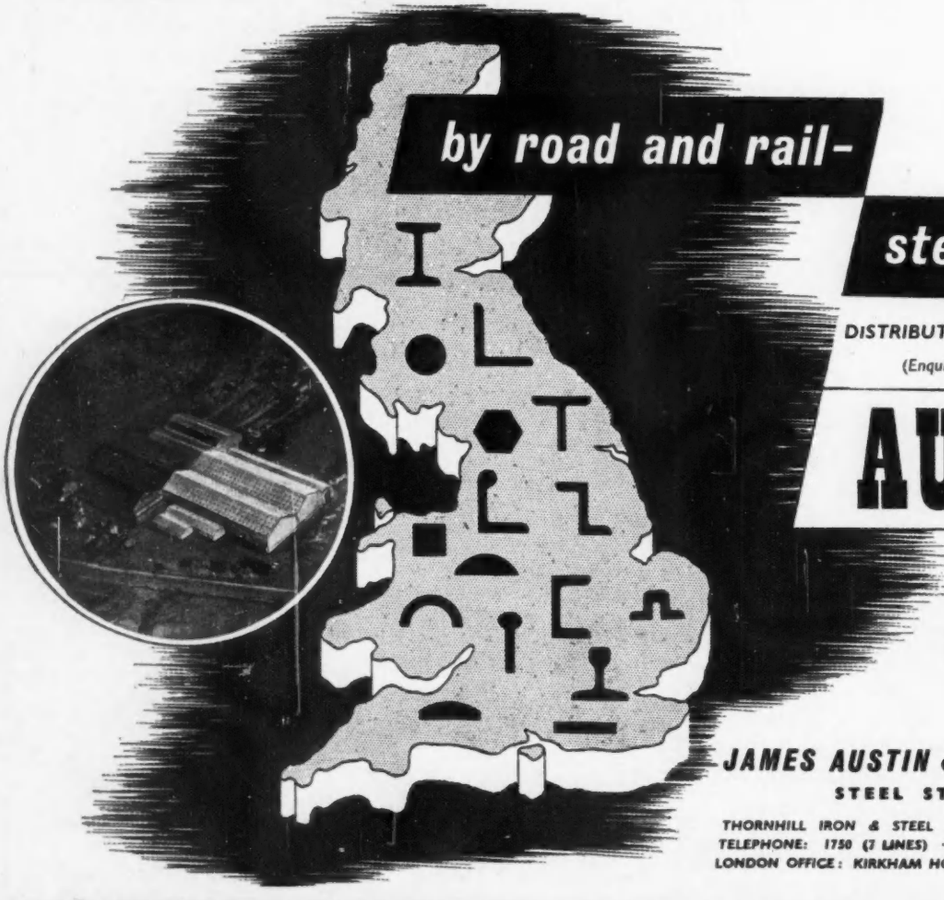

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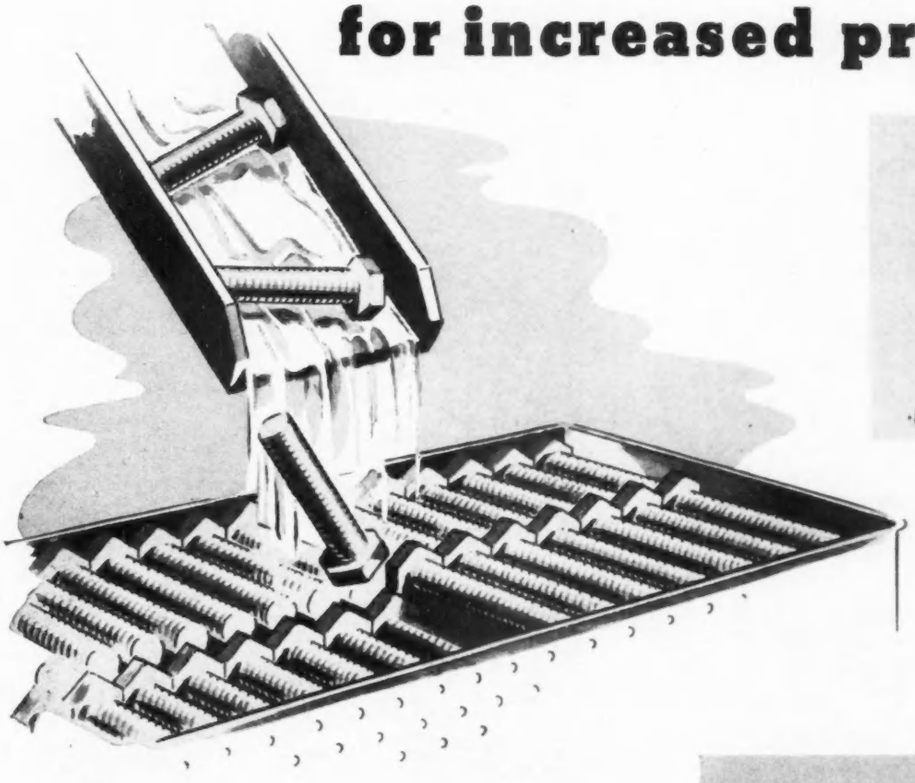

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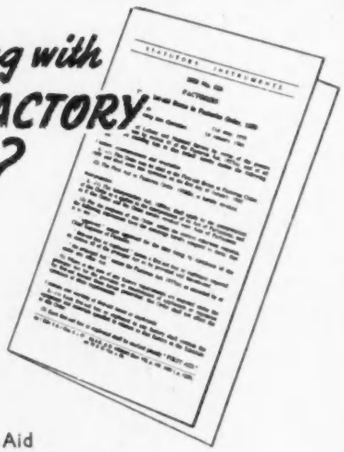

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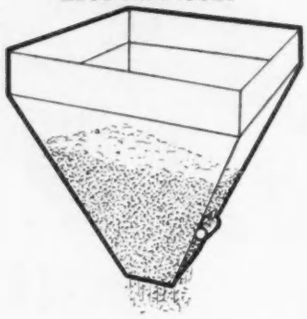
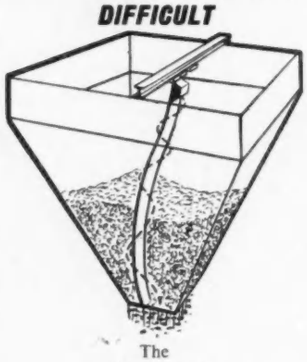


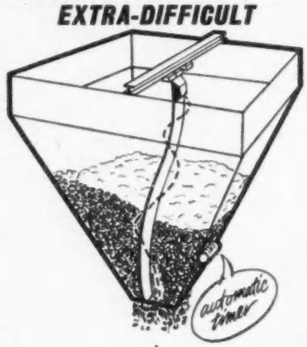
The installation of an external vibrator to a steel hopper.

DIFFICULT



The vibrating reed for application where external vibration is impractical due to structural or other difficulties and if the bunker is made of concrete.

EXTRA-DIFFICULT



A combination of internal and external bunker vibration. Where the external vibrator is timed for 'on and off', the vibration frequency, on slowing down, goes through the natural resonance of the bunker, irrespective of load material contained.

trouble-free bunker discharge

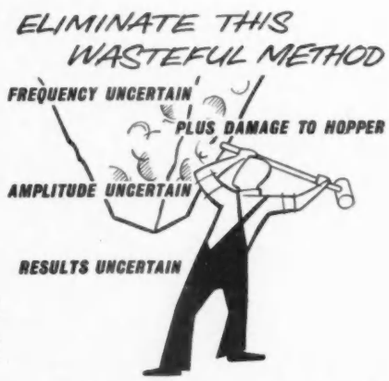
The primitive, inefficient method commonly used for clearing material which sticks in a storage bunker is by applying a sledge hammer to the side of the hopper. This is a form of low frequency, uncontrolled vibration. When vibration is applied at the *correct* frequency, the *correct* amplitude and the *correct* point of application, almost any material can be satisfactorily discharged.

SINEX has the experience with a wide variety of materials and a wide range of hopper designs to recommend how vibration should be applied effectively to solve *your* particular problem.

The three examples illustrated show three different combinations which are typical of many applications, but even these, whilst using the same type of unit, can only be effective if the types of unit themselves are placed in the correct position and have the correct frequencies and amplitudes of vibration, to suit the characteristics of the material to be discharged.

It would pay you, therefore, to make use of our experience and to consult us on your particular problem.

Send for relevant details and information sheet.



These are some of the many materials which we have handled satisfactorily and ensured trouble-free bunker discharge: Pulverised and small coal, iron ore, coke, lime, flour, grain, grist, foundry sand, soda ash, cullet, sand, gravel, granite chips and all road stone materials.

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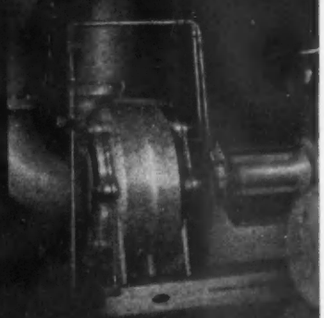
Why not discuss Linatex pumps with our resident area engineer?

Actual site photograph of the Calverton installation



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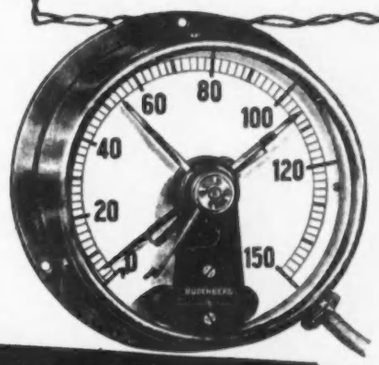

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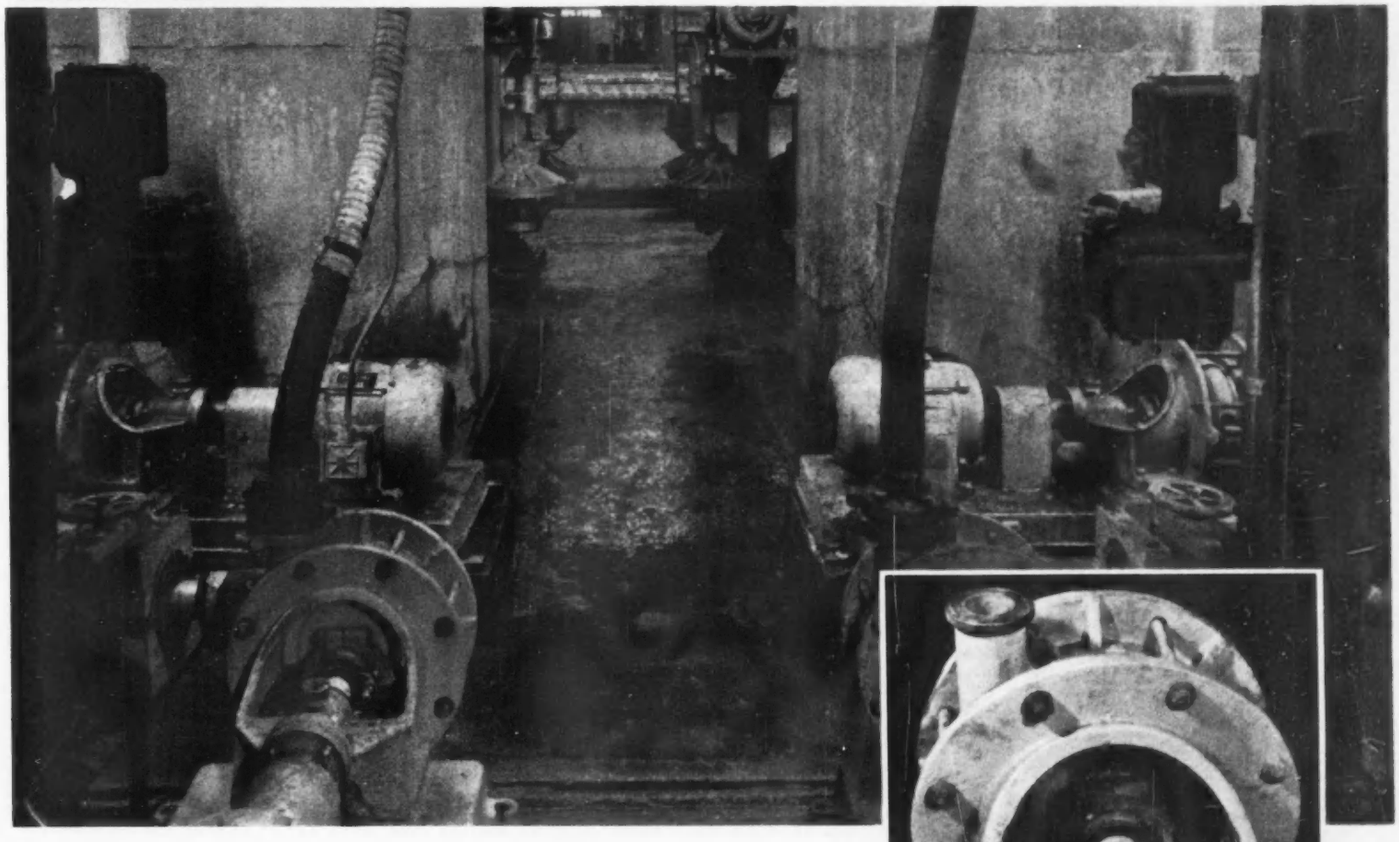
'FLUON' INCREASES PRODUCTION EFFICIENCY IN INDUSTRY



Pumps which handle highly corrosive nickel sulphate solutions, containing abrasive materials, up to temperatures of 70° C., at Johnson, Matthey and Company Limited, Brimsdown, Middlesex, showing asbestos/'Fluon' gland packings made by Crane Packing Ltd., Slough. The inset shows a close-up of the packing rings in one of the centrifugal pumps.

'Fluon' cuts maintenance costs, increases efficiency for Johnson, Matthey and Company Limited

Preformed packing rings made from plaited asbestos rope impregnated with 'Fluon' p.t.f.e. by Crane Packing Limited, are used for gland packings in the centrifugal pumps at Johnson, Matthey and Company Limited. These pumps handle highly corrosive nickel sulphate solutions, containing abrasive materials, up to temperatures of 70°C. These solutions attack all hydrocarbon lubricants, causing conventional gland packing rings to harden.

Johnson, Matthey and Company Limited had to adjust the former gland packing daily and replace packing rings every 200 pump-working hours.

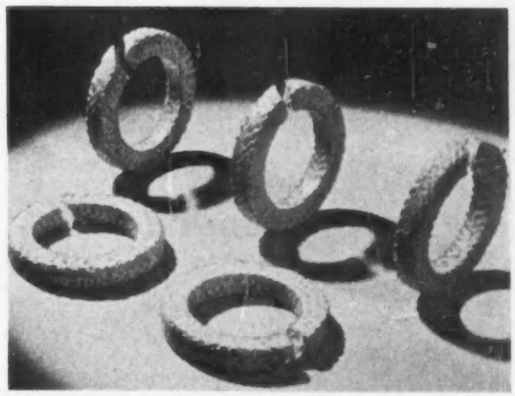
Since changing to asbestos/'Fluon' packing rings there has been a remarkable improvement. At first, gland adjustments were made every two or three days. After a few weeks *no attention was needed at all.* The rings were found to be in *perfect condition after 7,000 hours'* pumping the abrasive-free nickel sulphate solution. When the solution contained abrasives, the life of the rings was slightly shorter, but *many times longer than that of any other packing.*

Trials were run over two six-month periods and these results were obtained:

(1) 67 conventional packing rings were replaced, over six months, in five 2" pumps. In the next six months, only 4 asbestos/'Fluon' rings were replaced.

(2) 168 conventional packings were replaced, again over six months, in five 2½" pumps. In the following six months, only 31 asbestos/'Fluon' ones were replaced.

Initially, these new rings cost more. The extra cost is offset many times over in reduced maintenance costs and greater running efficiency of the pumps.



Plaited asbestos rope impregnated with 'Fluon' p.t.f.e. and made into preformed gland packings by Crane Packing Ltd., Slough.

'FLUON' *'Fluon' is the registered trade mark for the polytetrafluoroethylene manufactured by I.C.I.*

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P467

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The REEVES Vari-Speed Motodrives are complete variable speed power packages designed to give ultimate performance and operating efficiency to applications in every industry. Right Angle Reducer units are also offered with the same rugged construction and simplicity of operation for year-round dependable service.

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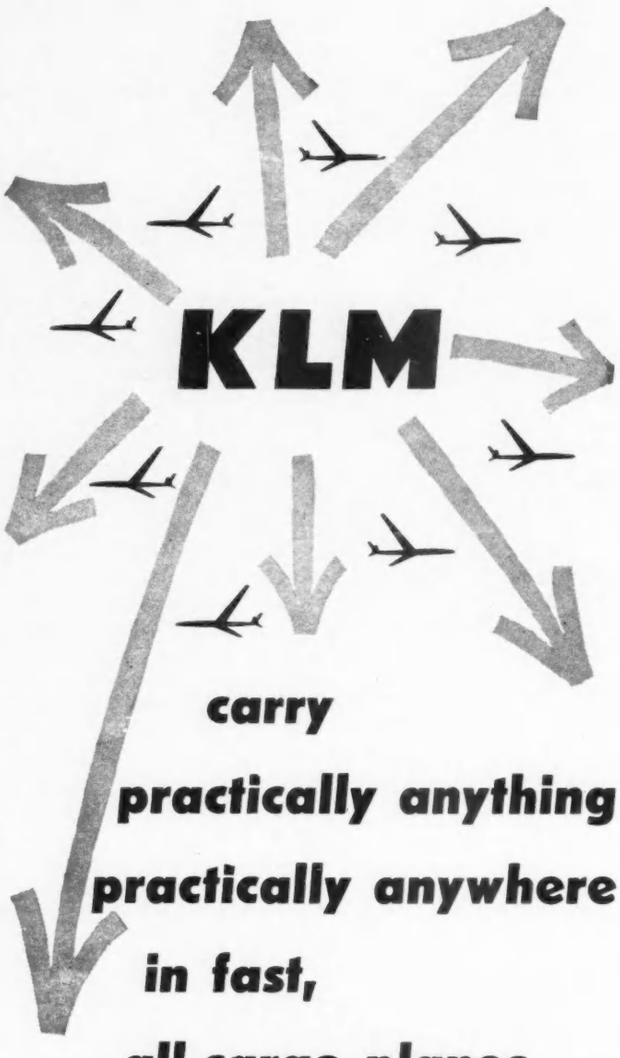

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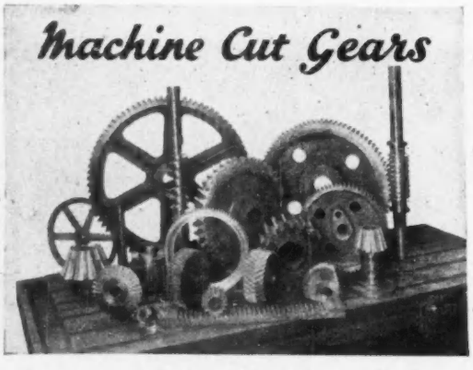

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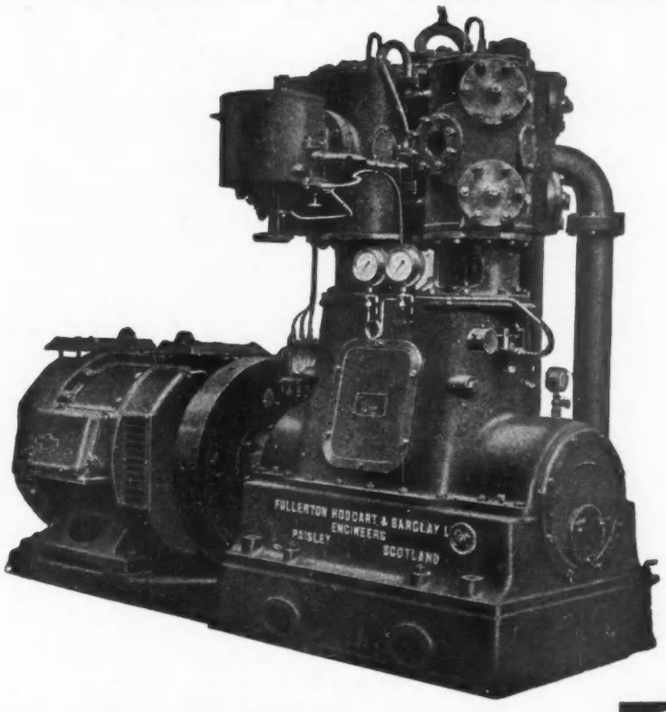

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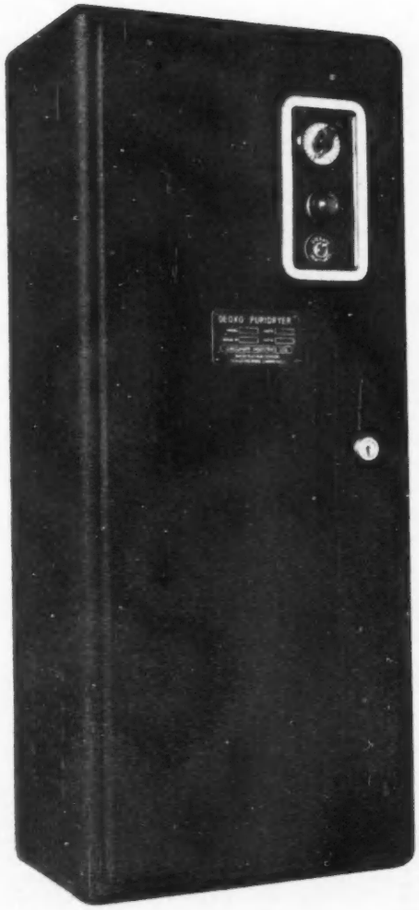

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✱ *Further information regarding the Deoxo Puridryer and Deoxo Catalytic Gas Purifiers is available on request.*

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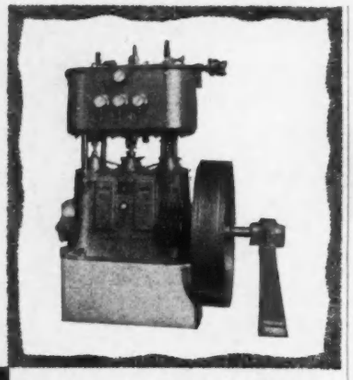

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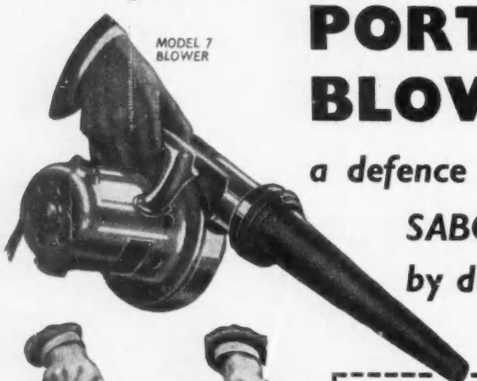

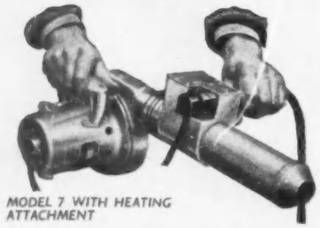
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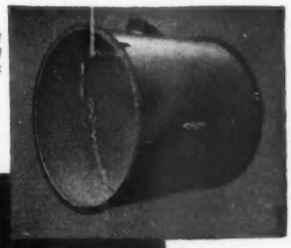

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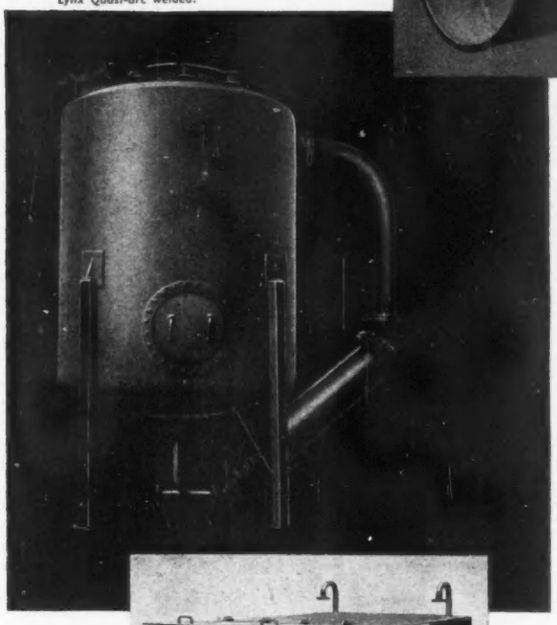
1,000 gall. kettle in ¼" copper. Lynx Quasi-arc welded.



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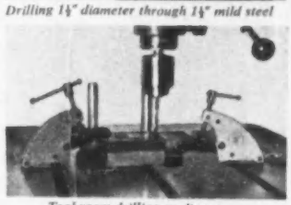

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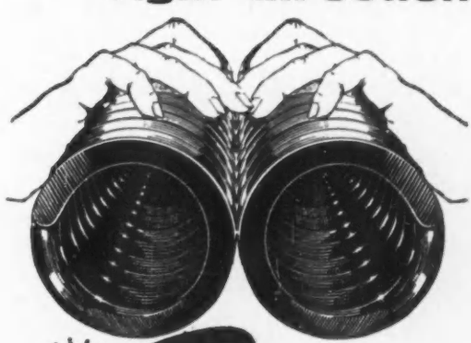

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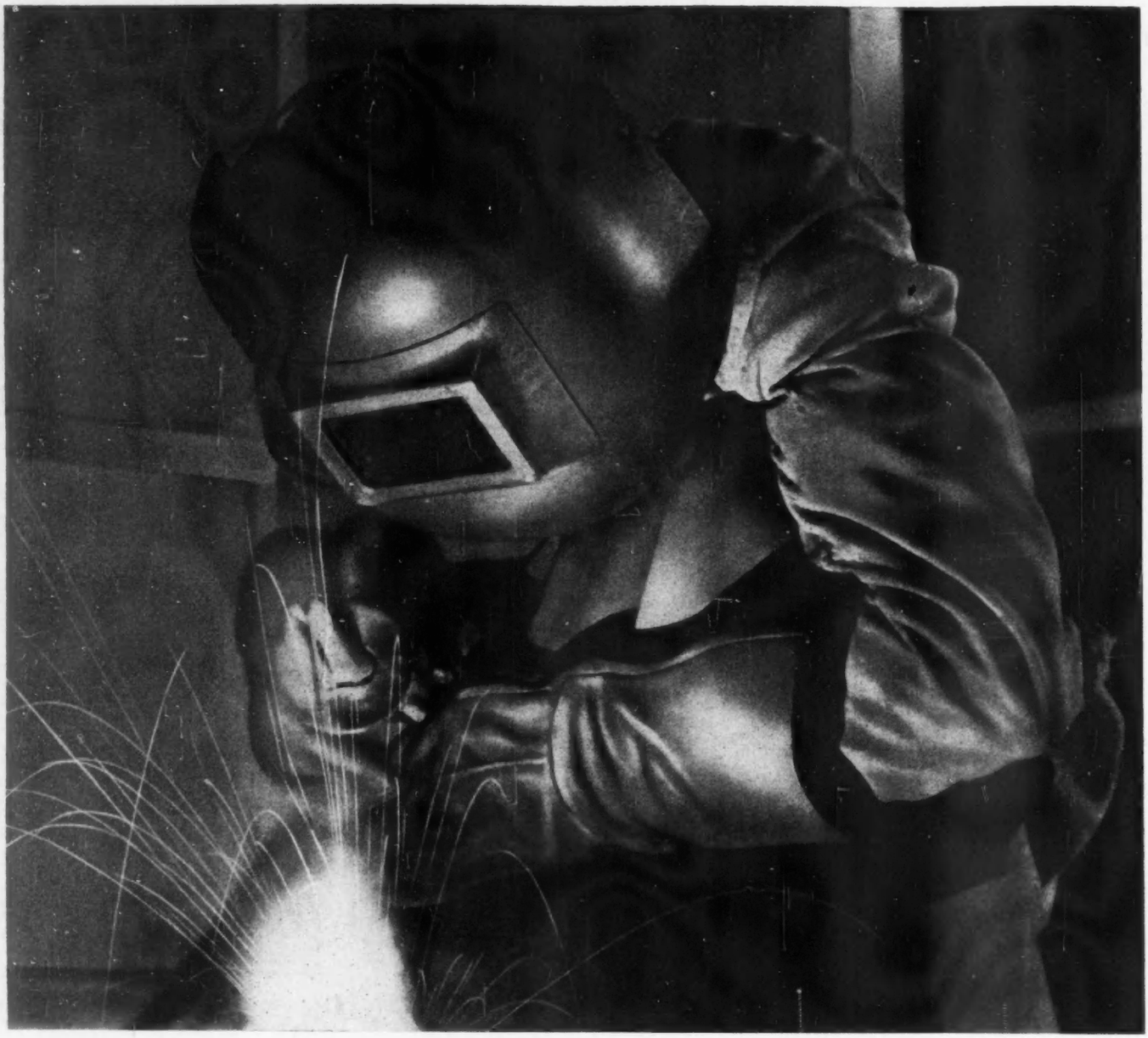

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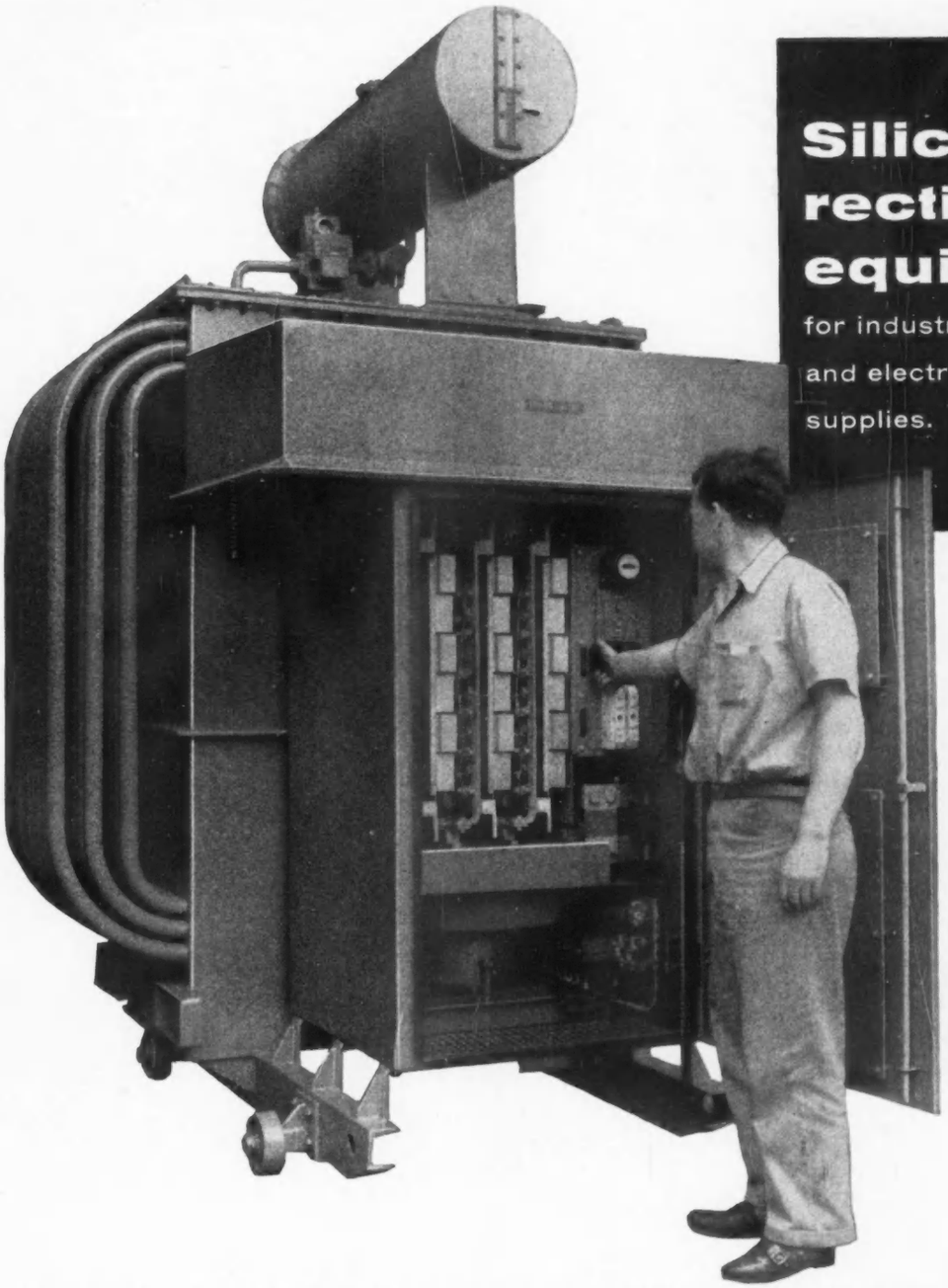

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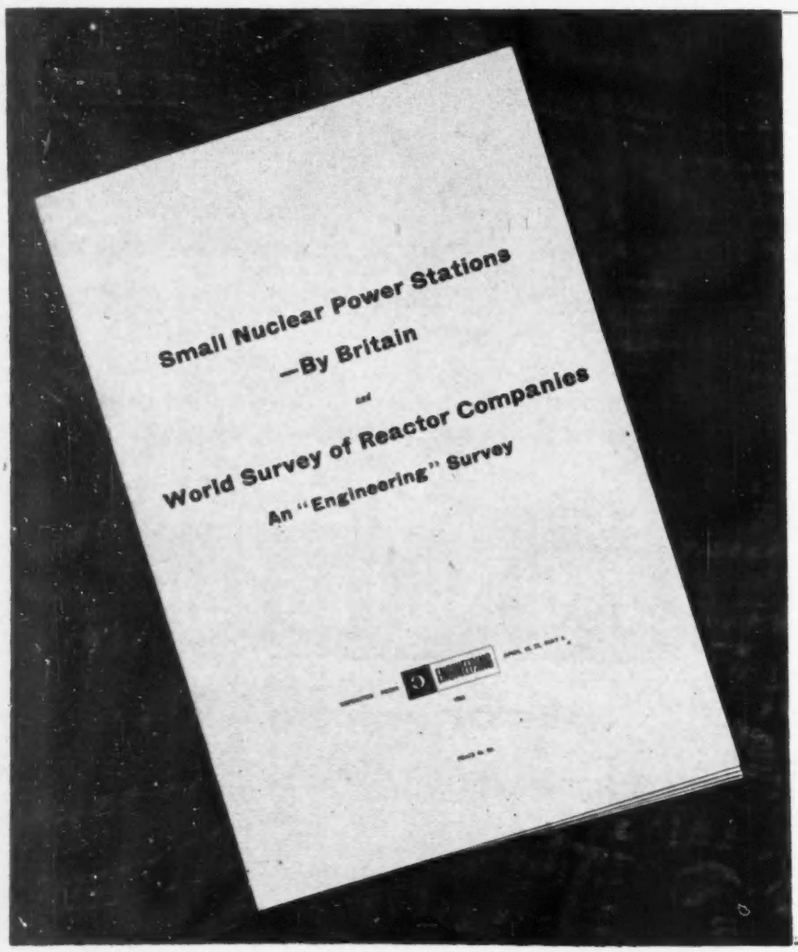

Britain's projects for small reactors (11-60 MW) are described by the heads and chief project engineers of nuclear departments of Babcock and Wilcox; de Havilland Engine Company; English Electric Company; GEC-Simon-Carves Atomic Energy Group; Hawker Siddeley Nuclear Power Company; Humphreys and Glasgow; Mitchell Engineering; Rolls-Royce and Vickers.

This reprint from 'Engineering' also contains a unique chart of World reactor companies and their associates, and of their activities in the nuclear field.

Reprinted from 'Engineering', April 15, 22 and May 6, 1960. Price 4s. post paid from 36 Bedford Street, London WC2.

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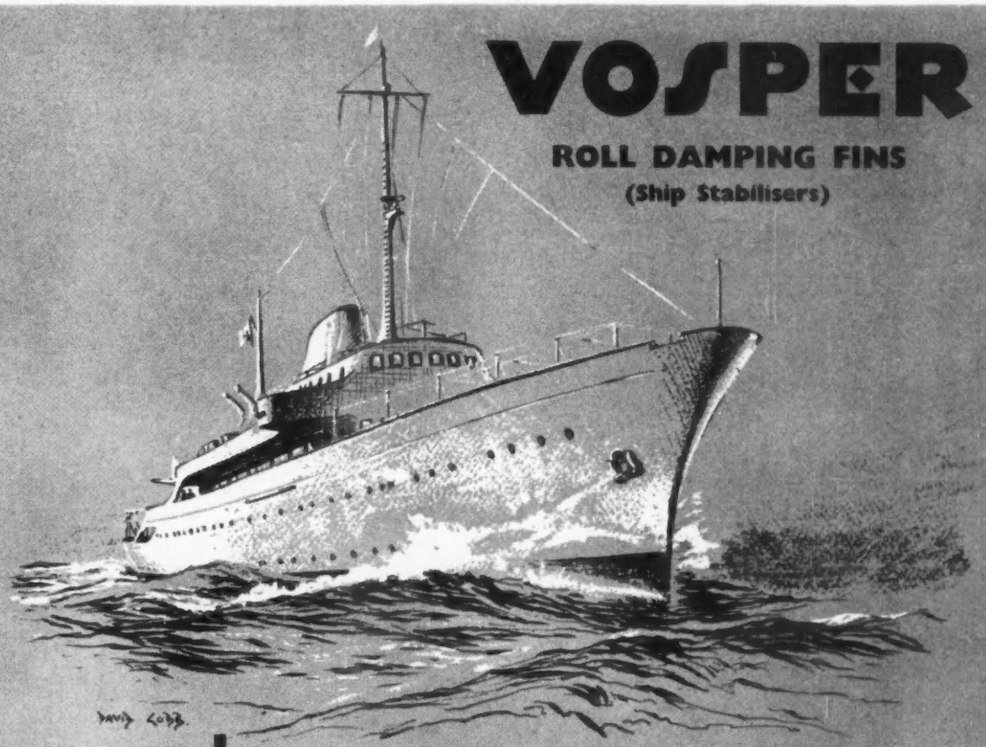

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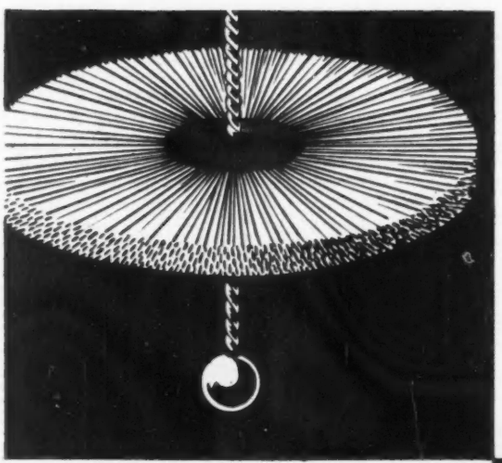

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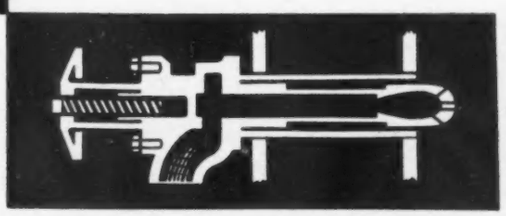

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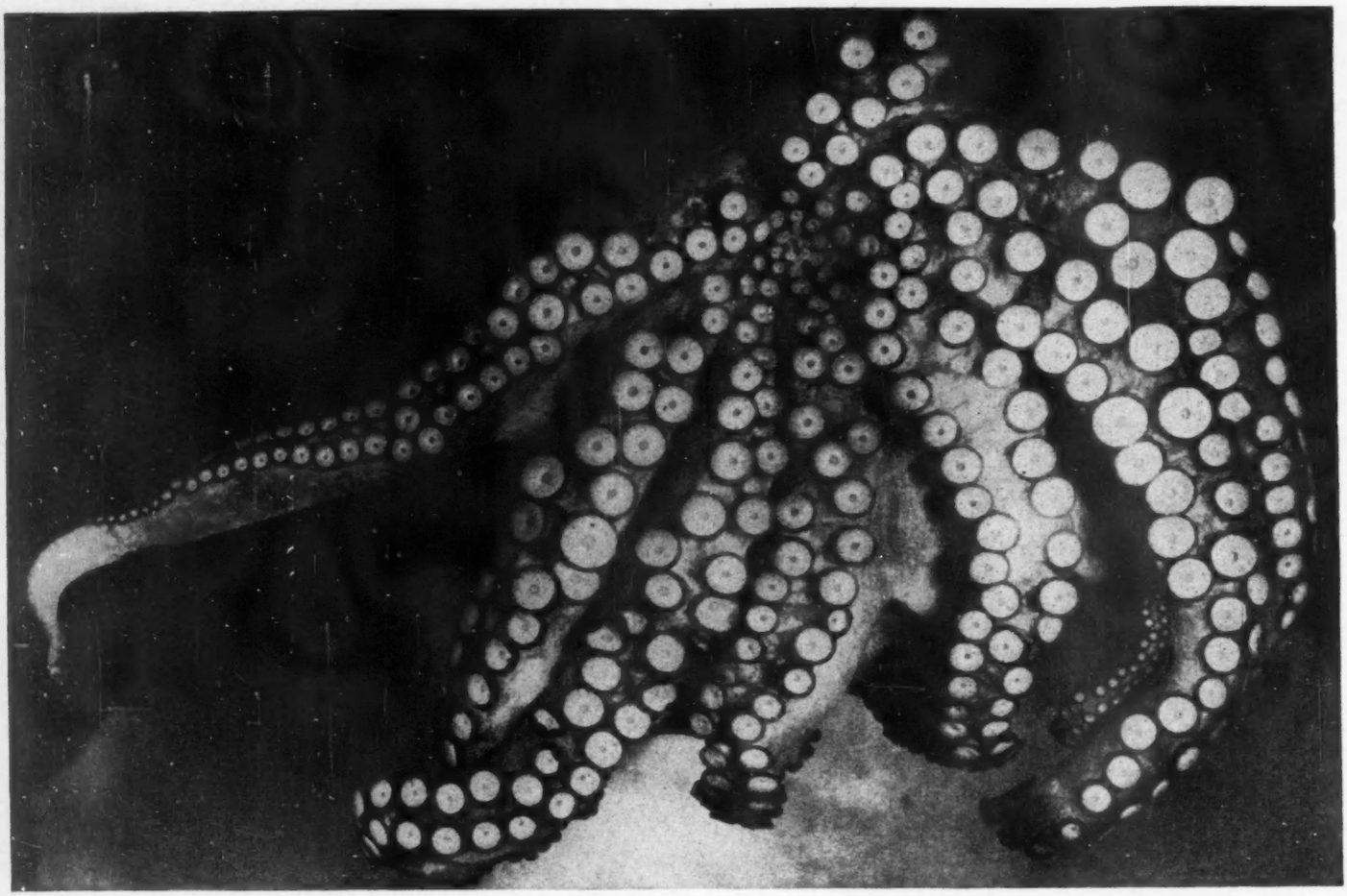

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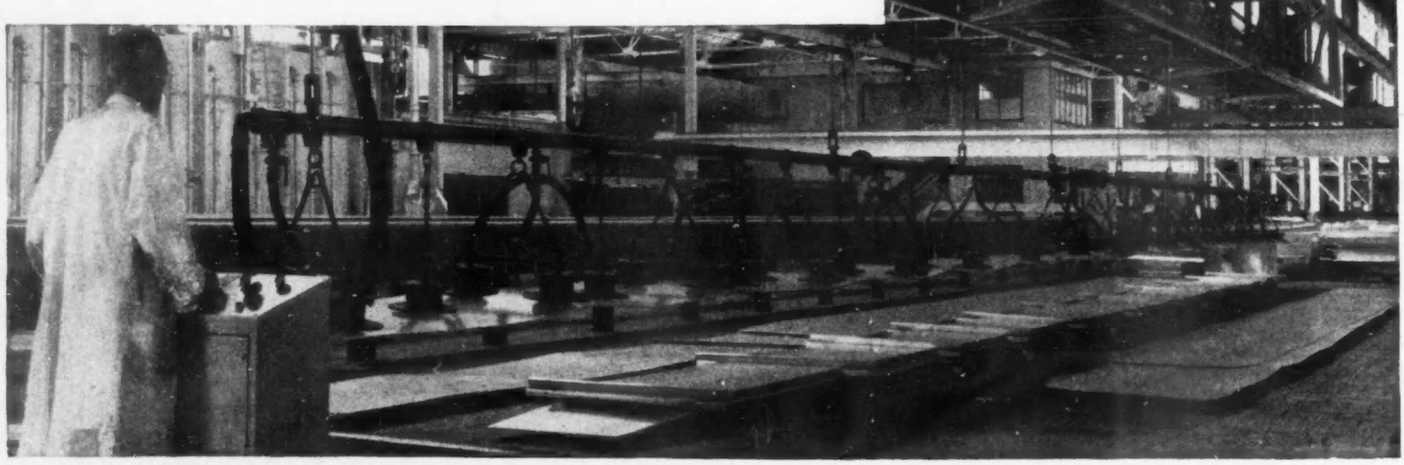

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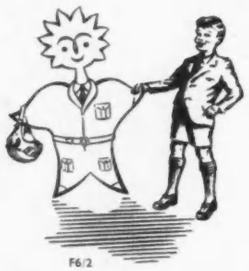

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